DOCUMENT RESUME

ED 133 230 SE 021 905

AUTHOR	Knapp, Clifford
TITLE	Priority One: Environment. Open Lands and Wildlife.
INSTITUTION	Union Township Board of Education, N.J.
SPONS AGENCY	Bureau of Elementary and Secondary Education (DHEW/OE), Washington, D.C.; New Jersey State Dept. of Education, Trenton. Div. of Research, Planning, and Evaluation.
PUB DATE	[75]
NOTE	40p.; For related documents, see SE 021 898-906; Not available in hard copy due to copyright restrictions
EDRS PRICE	MF-$0.83 Plus Postage. HC Not Available from EDRS.
DESCRIPTORS	*Ecology; *Environment; Environmental Education; *Instructional Materials; Land Use; *Natural Resources; *Secondary Education; *Units of Study (Subject Fields); *Wildlife Management
IDENTIFIERS	Elementary Secondary Education Act Title III; ESEA Title III

ABSTRACT

This unit is one of a series on environmental education for grades 1-12. The unit is designed to be used with secondary school students and includes the following sections: (1) Preface; (2) Dead or Alive; (3) Finding Out by Looking Closely; (4) A Year in the Life of a Twin Fawn; (5) Ecology; (6) The Tools of Wildlife Management; (7) Land Use; (8) Helping a Threatened Population, A Model for Action; (9) Suggested Strategies for Action; (10) Appendices; and (11) Schedule Sheet for the Unit. References to audiovisual materials, worksheets, and activities are made; these materials are not included with this publication but may be purchased. The materials in this unit have been validated as successful, cost-effective, and exportable by the standards and guidelines of the U.S. Office of Education. (RH)

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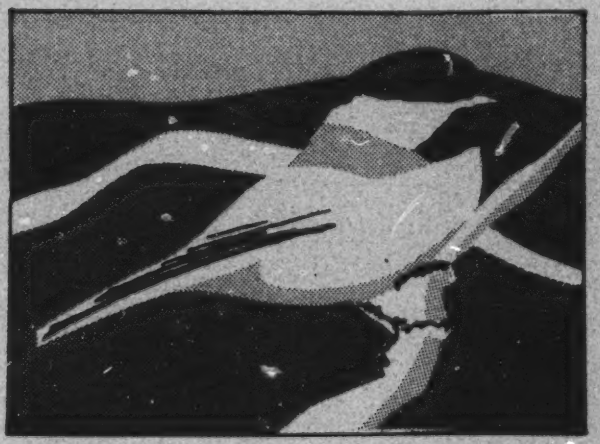

OPEN LANDS AND WILDLIFE

SE 021 905

2

PRIORITY ONE
ENVIRONMENT

POLLUTION CONTROL EDUCATION CENTER
Township of Union Public Schools
Union, New Jersey

OPEN LANDS AND WILDLIFE

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The materials presented herein were prepared pursuant to a Grant from the New Jersey State Department of Education under provisions of the Elementary and Secondary School Act of 1965, Title III.

OPEN LANDS AND WILDLIFE

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PREFACE

"The buffalo is gone, and of all his millions, nothing is left but bones. . . The wolves that howled at evening about the traveler's camp-fire, have succumbed to arsenic and hushed their savage music. . . The rattlesnakes have grown bashful and retiring. The mountain lion shrinks from the face of man, and even grim Old Ephraim, the grizzly bear, seeks the seclusion of his dens and caverns."

Francis Parkman (1892)

As long ago as 1892, people noticed that some species of wildlife were vanishing. Have you thought much about rare and endangered animals? Does it make a difference in your life when more and more of these animals become extinct?

Do you think that Parkman was sorry to see that buffalo, wolves, rattlesnakes, mountain lions, and grizzly bears were disappearing? How does his description of the animals lead you to understand how he felt about them?

All the animals mentioned, except the buffalo, are predators. This means that they kill and feed upon other animals. Do you like plant-eating animals better than meat-eating animals? Does it make a difference? Why do you think predators such as wolves, rattlesnakes, and bears are often shown in stories to be villains?

DEAD OR ALIVE, A STORY

A wise old hermit lived in the woods outside a small midwestern town. The wisdom of this man was widely known throughout the community. Many of the young men in the town spent a good deal of their time trying to disprove his wisdom, so they could tell the world, "He's not so smart after all . . ."

One day, two of the young townsmen were sitting on the bank of the river, indulging in their favorite sport—looking for a way to trick the old hermit and end the legend of his wisdom.

Suddenly one of the young men reached out and caught a sparrow that had perched on a limb above his head. "Well," said he, "now I know how to out-fox the old hermit. We'll go to his cave, and I'll hide the sparrow in my hands so he can't see it. I'll ask him what I have in my hands. If he can tell me that it's a bird, I'll ask him whether it's dead or alive. If he says it's alive, I'll squash my hands and the bird will be dead. But if he says dead, I'll open them and let the sparrow fly away."

Hurrying through the woods, they soon came to the hermit's cave. "Old man," cried the tormentor, "what do I have in my hands?" The old man looked at him thoughtfully and then answered him, "A bird, my son."

"Tell me, old man, is it dead or alive?"

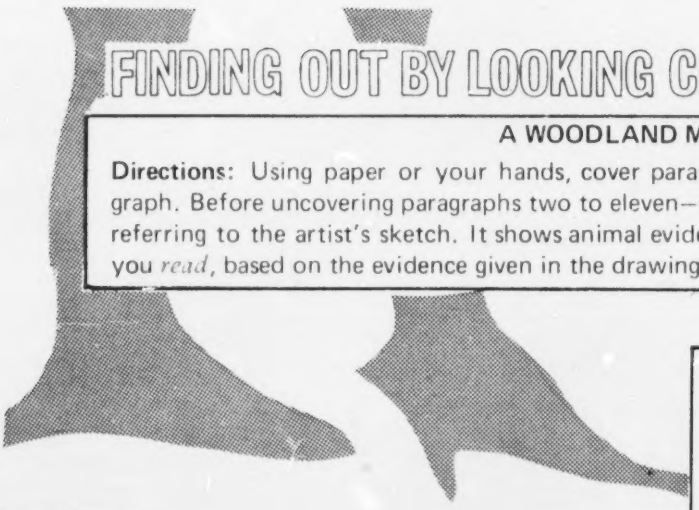
For a long time the old man just looked at the boys and then he answered, very slowly, very deliberately, "It's up to you, my son; it's in your hands."

Would you try this experiment with a living thing in your hands? Do you know how much power you really have in your hands for protecting wildlife? After you have read this story, you will have the opportunity to take a stand on some of the key issues concerning open lands and wildlife today. When you finish your **Attitudes and Values Assessment**, share your views with the other students in your class. Take your stand.

FINDING OUT BY LOOKING CLOSELY

A WOODLAND MYSTERY

Directions: Using paper or your hands, cover paragraphs two to eleven, but not the first paragraph. Before uncovering paragraphs two to eleven—one at a time—try to answer the questions by referring to the artist's sketch. It shows animal evidence in the snow. How much of the story can you *read*, based on the evidence given in the drawing?



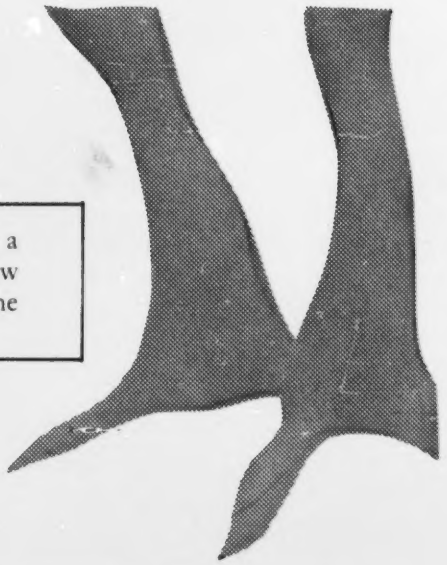
5. A blood stain in the snow at **G** is the first trace that the rabbit is dodging something that has been chasing it. When a rabbit runs, the hind feet actually go in front of the fore feet, so you know the rabbit is moving from **C** to **D** to **E** and so on. Why can't the tracks of the enemy be observed in the snow?

4. At **D**, **E**, and **F** you will notice rapid changes of direction. What might be happening to cause this? Notice that as the rabbit runs faster, the distance between the fore feet and hind feet widens. Notice also that the prints of the hind feet are in front of the prints of the fore feet. Can you guess why this happens?

3. Notice that the rabbit tracks change in two ways between **B** and **C**. You can see the print made by the tail when the rabbit was sitting. You can see only the prints of the front feet (small tracks) and the hind feet (oblong tracks) made when he was moving.

2. The bare leaves would indicate that the animal arrived beneath the pile of brush before the snow started to fall. What happened at **B**? Can you tell what kind of animal jumped from beneath the brush pile at **A**? What parts of the animal can you identify from the print?

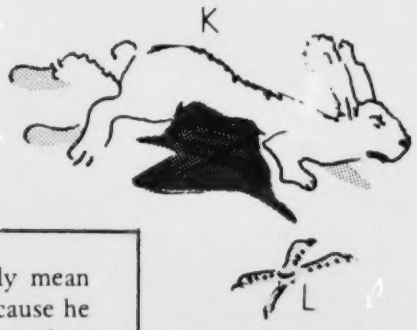
1. Starting at **A**, describe what the animal might have been doing. What do the dry leaves on the ground tell you about the weather when the animal arrived at that spot?



6. What kinds of flying predators might attack a rabbit for food? The finger-like marks show where the wings of a large bird touched the snow.

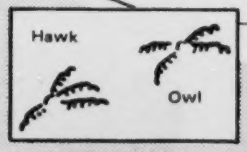
7. More blood is found at **H** and now the mystery is starting to clear up. The rabbit is being chased by a flying predator and therefore there are no tracks on the ground. What are the finger-like marks on each side of the rabbit tracks at **J**?

8. Eagles, hawks, and owls might attack rabbits. What are the clues at **K**, **L**, and **M** that might tell you which of these it is?

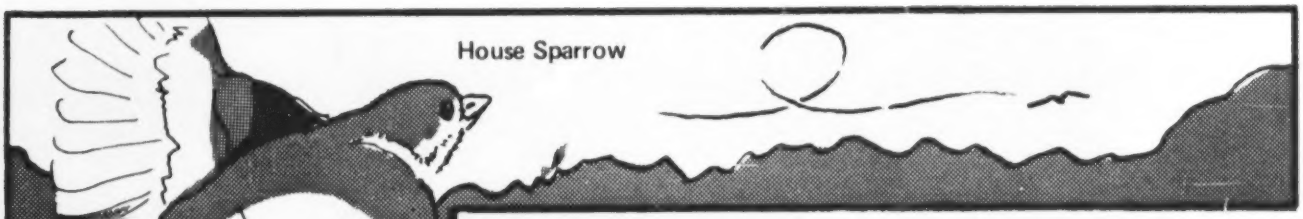


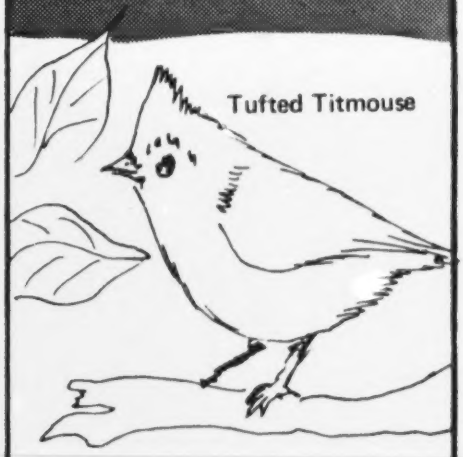
9. The remains of the rabbit at **K** usually mean that the attacker was not an eagle because he would have carried the prey away. The track at **L** and the feather in the tree at **M** determine whether the attacker was a hawk or an owl. Can you identify the bird from these signs?

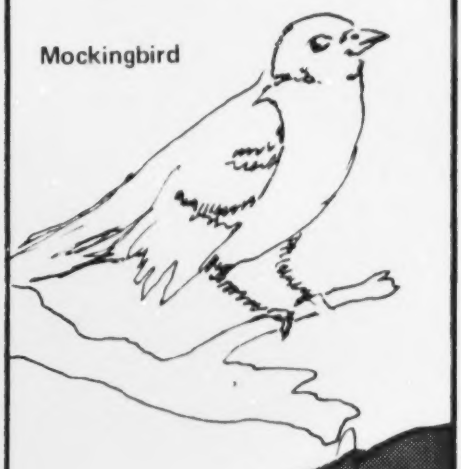
10. The track at **L** was made by an owl. A hawk has a different track as shown at the bottom left-hand corner of this page. What type of owl might it be? The feather at **M** has three brown bars across it. Does this help you identify the owl?



11. The feather belonged to a Barred Owl which killed and partially ate the rabbit. Were you able to *read* many of the clues left by these animals?







HINTS FOR OBSERVING BIRDS

1. Most birds can be found in areas which contain a variety of plants. The areas where fields and forests, hedges and lawns, or shrubs and open areas meet are best for sighting birds.

2. Although it is usually helpful to approach birds quietly, they can sometimes be attracted to strange sounds. Try repeated, loud sounds such as *shush, shush, shush.*

3. Binoculars help in seeing details of birds, but bird watchers can identify many birds by sound. Purchase bird call records and memorize the sounds. It is sometimes helpful to imagine that the bird sounds resemble words, such as *whip-oor-will* or *drink your tea* (towhee) or *woit, woit* (cardinal).

4. Picture a shrub or tree as the face of a clock when trying to explain to someone else where a bird is located. For example, a bird at the very top of a tree would be located at the 12:00; one at the bottom at 6:00.

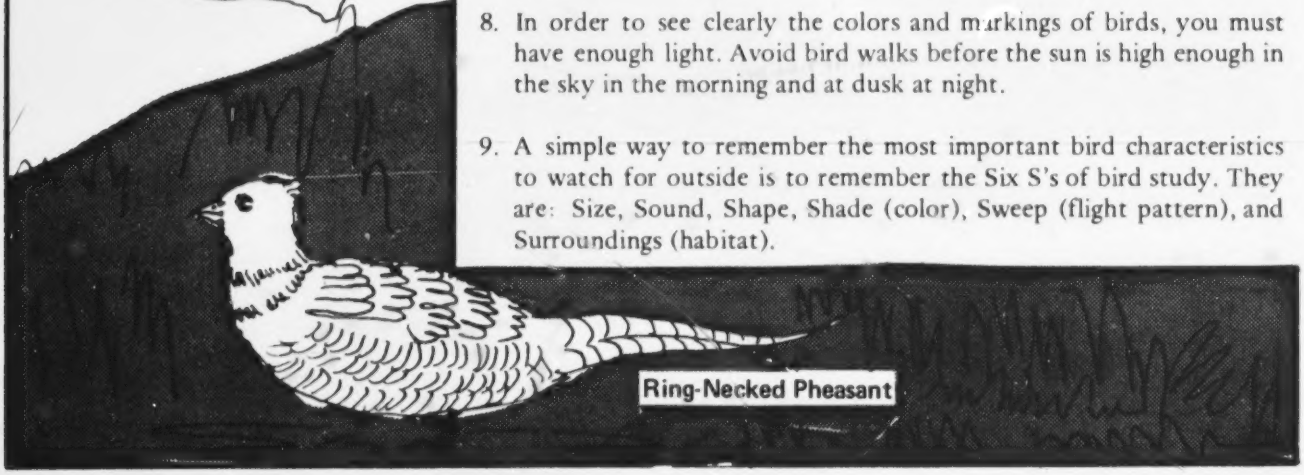
5. A feeder placed near a window can provide excellent bird observations. Place a variety of foods to attract many species.

6. Learn the size of the common sparrow, the robin, and the crow so you can compare the size of other birds to them. For example, a blue jay is slightly larger than a robin.

7. A good bird identification book is important for more serious bird watchers. Two suggestions are: *Birds of North America* by Chandler S. Robbins, Vertel Bruun, and Herbert S. Zim. Golden Press, New York and *A Field Guide to the Birds* by Roger Tory Peterson. Houghton Mifflin Company, Boston.

8. In order to see clearly the colors and markings of birds, you must have enough light. Avoid bird walks before the sun is high enough in the sky in the morning and at dusk at night.

9. A simple way to remember the most important bird characteristics to watch for outside is to remember the Six S's of bird study. They are: Size, Sound, Shape, Shade (color), Sweep (flight pattern), and Surroundings (habitat).



Analyzing What You See

1. Where did you see the bird? Was it flying overhead, in the woods, the border of the woods, in bushes, in an open field, or on a tree? Was it by a roadside, building, pond, garden, or stream?

2. In flying, did it go straight and swift, dart about with a wave-like motion, flap its wings constantly, soar on steady wings, or some combination of these?

3. What were its most striking colors?

4. Did it flash colors when flying? If so, where, and what color?

5. Were you able to obtain a wing feather? If so, make a sketch of its structure by using a magnifying glass.

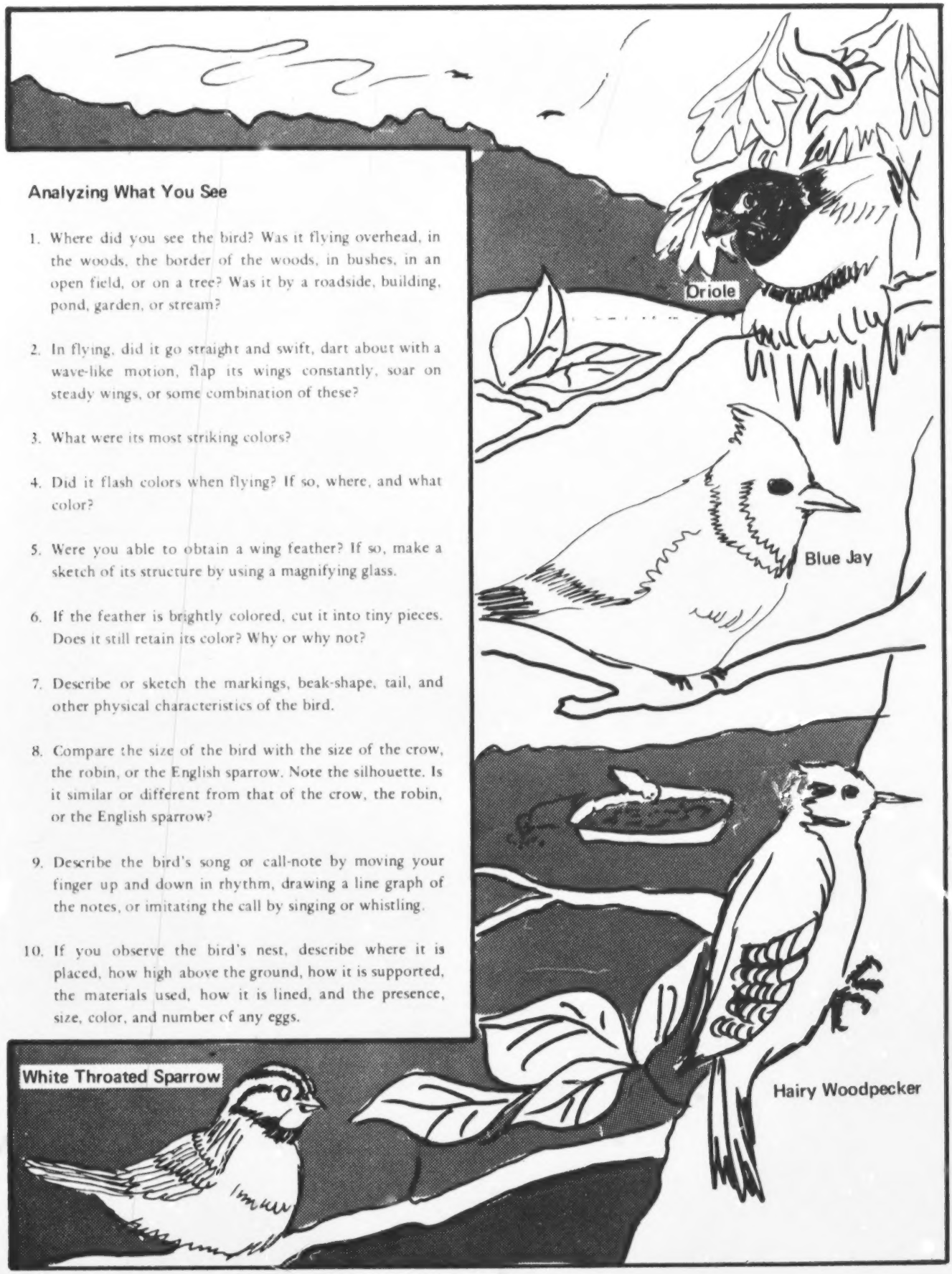
6. If the feather is brightly colored, cut it into tiny pieces. Does it still retain its color? Why or why not?

7. Describe or sketch the markings, beak-shape, tail, and other physical characteristics of the bird.

8. Compare the size of the bird with the size of the crow, the robin, or the English sparrow. Note the silhouette. Is it similar or different from that of the crow, the robin, or the English sparrow?

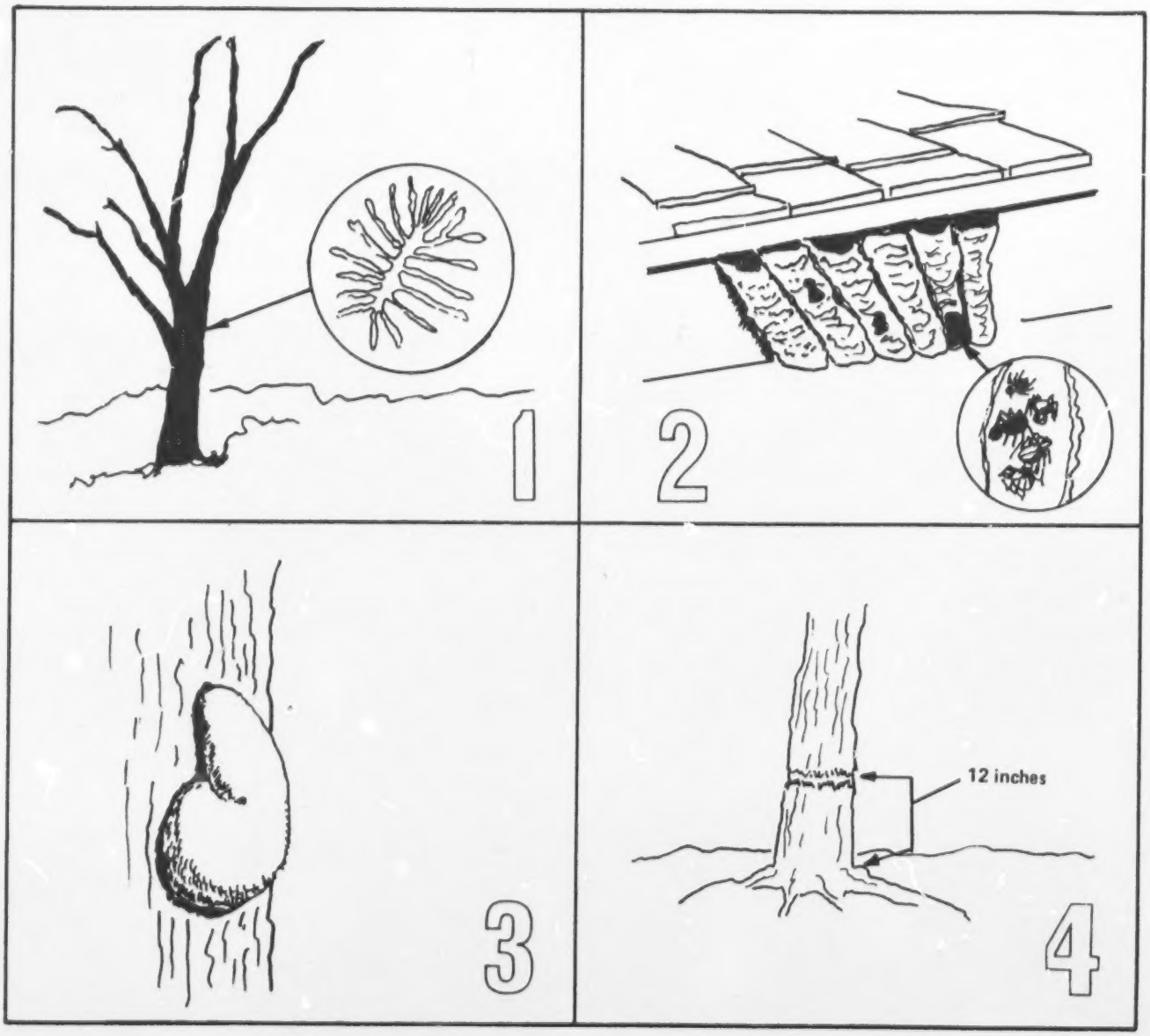
9. Describe the bird's song or call-note by moving your finger up and down in rhythm, drawing a line graph of the notes, or imitating the call by singing or whistling.

10. If you observe the bird's nest, describe where it is placed, how high above the ground, how it is supported, the materials used, how it is lined, and the presence, size, color, and number of any eggs.



WILDLIFE DETECTIVE GAME: THE EVIDENCE

Each illustration on these pages is a sketch of some type of animal evidence. The objective of the game is to explain exactly what the evidence is and how it was created, and then to identify the animal. To help you solve the mysteries, you will receive a copy of ***Worksheet 3, Wildlife Detective Game: The Clues.***



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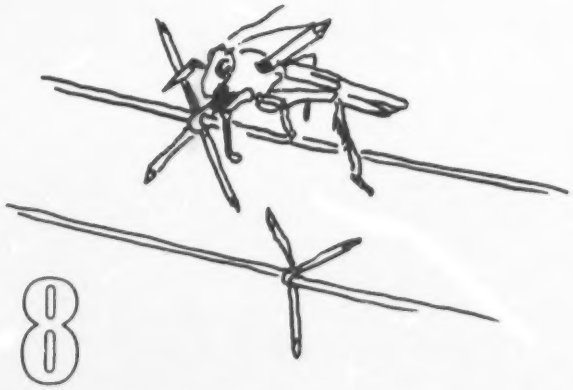

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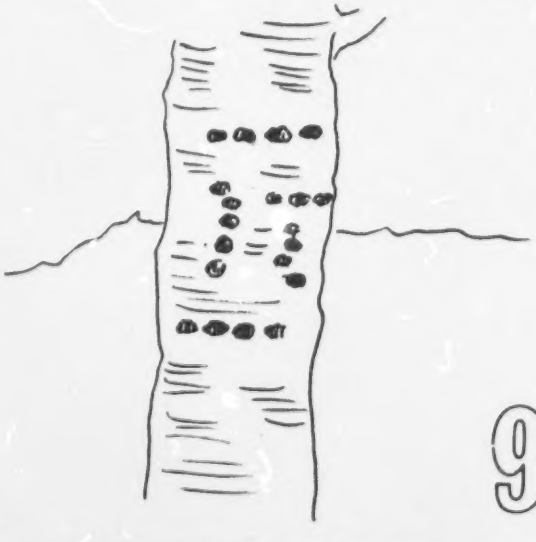

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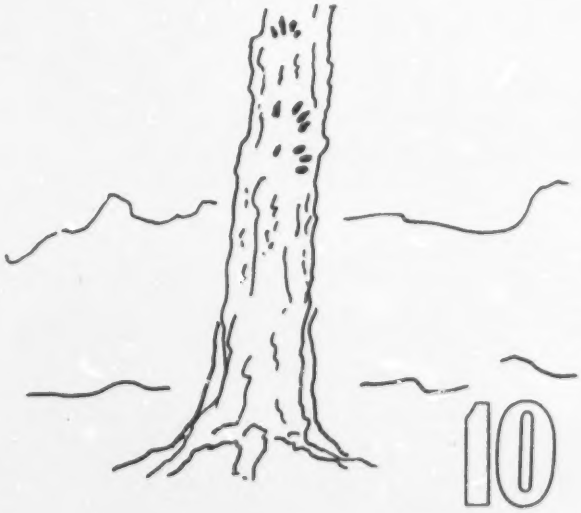

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A YEAR IN THE LIFE OF A TWIN FAWN

It was May and the twin fawns were born. Even as their mother licked them clean, strength flowed into the young bodies. The food supply in the valley had been plentiful that year for the white-tailed deer. This was one reason that twins had been born. Usually single fawns are born when life is hard for the herd. The fawns' mother, a 160-pound doe, had been able to browse on at least twelve pounds of vegetation each day for the past year. Tender leaves and twigs of red maples, dogwoods, and poplars from the forest *habitat*,* and alfalfa, corn, and clover from the field habitat had been her major diet. She also fed upon acorns, her favorite food, which the many oak trees provided.

The deer herd of about sixty animals lived in a beautiful valley about one mile square. There was one farm in the valley and because of the many edges where fields and forests met, the food was abundant. In the early 1700's, when this area was first settled, the white-tailed deer had been plentiful. By 1900, however, the deer population had been greatly reduced by the human population's appetite for venison.

Soon after 1900, government officials had restocked the deer herd and given them greater protection by laws. The herd began to increase. Young plants grew where forests once stood and yielded an abundance of food. The herd continued to increase. In fact, there were more deer by 1930 than when the Indians had roamed the forest.

The number of deer that can be supported by the available foods on the land is known as the *carrying capacity* of the land. Did you know that a single pair of deer can produce a herd of two hundred in ten years if conditions in the environment are suitable? The carrying capacity of the valley for white-tailed deer in the year of our story was sixty.

The newborn twins gained strength quickly. After three weeks they were able to follow the doe along the well-worn trails. One day a pack of wild dogs caught their mother's scent and approached from downwind. The doe quickly led the twins into a thicket and raced off to safety. The fawns hid quietly beneath the underbrush as the pack raced by. The twins were not discovered because they were motionless, had no body scent, and their speckled coats blended in with the leafy background. These safety features of the twins are called *adaptations* for survival, and they really worked! The *predators* passed within a few feet of the still bodies under the shrubs. The twins did not become the *prey* of the dog pack that day.

By summer, the white-tailed twins were able to roam with the herd over most of the length of the valley. The traveling distance or *range* for the herd was about one square mile, although some of the bucks did cover a much larger area. The density, or number of deer in the area, increased during the summer as new herds entered the valley to feed. Then the valley, with a carrying capacity for sixty deer, had almost a hundred deer to support. It became harder and harder for the twins to reach the tender branches of their favorite plants.

Deer are browsing animals and fill an ecological *niche* as *consumers* of vegetation. They feed mostly on leaves, twigs, and fruits of trees and shrubs, as well as on grasses and other low-growing plants. They feed first on the best tasting and most nutritious plants, but when too many deer occupy an area, over-browsing occurs. This means that the most popular, most nutritious plants have been eaten, and the diet of the deer becomes less and less nutritious. By fall, the twins were forced to eat more and more evergreens like pine, spruce, and mountain laurel, foods not as nutritious as their regular diet of the summer before. The female twin, who started out smaller at birth, began to show signs of starvation first. She was usually the last to get at the food. By late fall almost all of the branches were far above her reach.

* Check your ECOLOGY GLOSSARY on pages 34 and 35 for the definitions of the italicized words.

One of the natural causes of death in the wild is starvation. When food is scarce, it becomes the chief *limiting factor* in the survival of a deer *population*, or any other type of population. *Competition* for space and food is a fact of life which is shared by all living things. Other limiting factors that can strike a deer herd are disease, parasites, severe winters, and predators such as wild dogs or man.

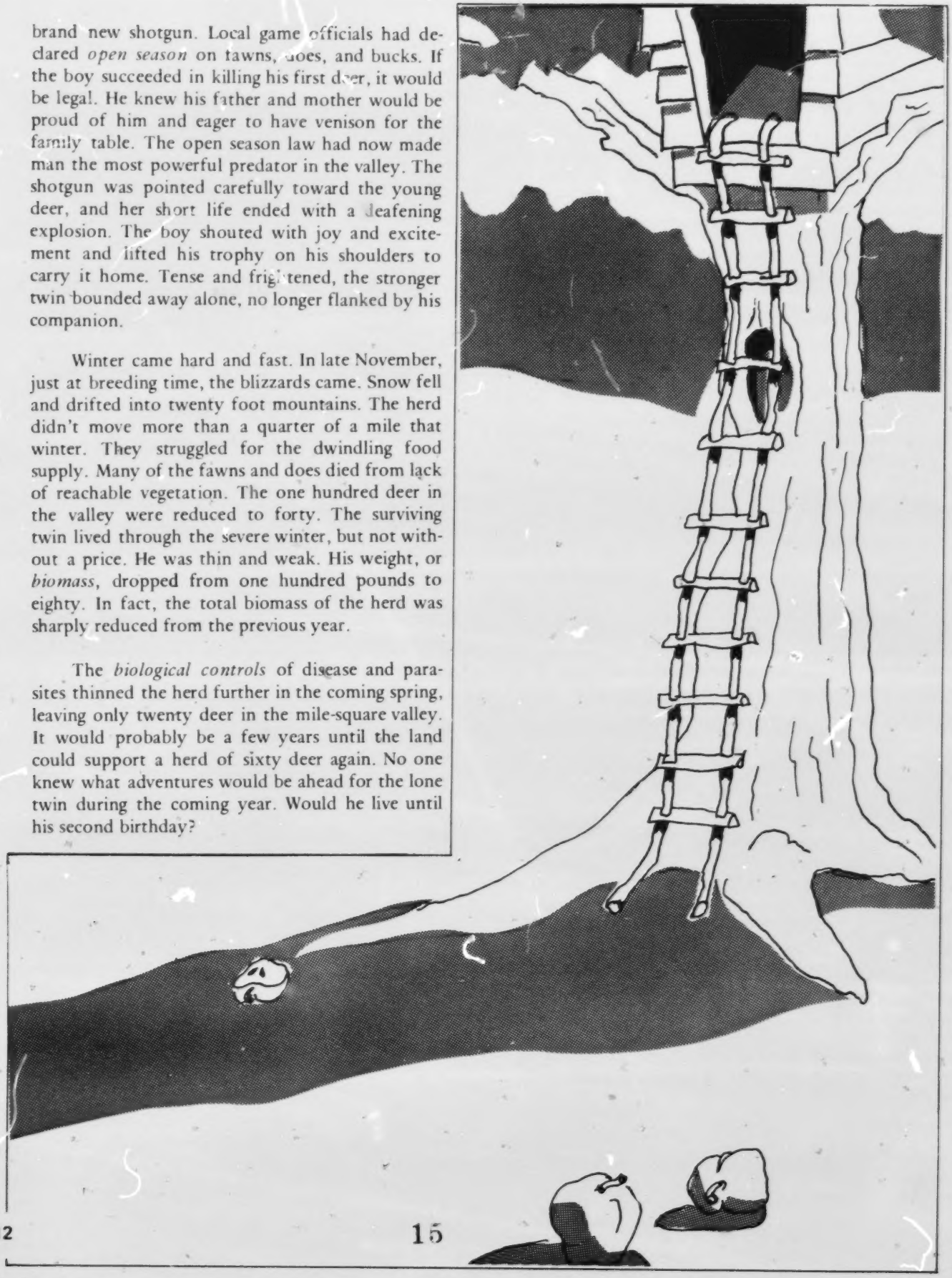
Does it seem strange that a plentiful food supply one year can mean a shorter life span for each deer the next year? Deer move into an area where the food is plentiful. If **more available food** means **more babies produced**, then there will be deaths in the herd due to an eventual competition for food. In nature, death prevents a population from increasing beyond the carrying capacity of the land.

The stronger male twin could now outrun his small, frail sister. One day they wandered very close to the farm to eat some of the fallen apples in the orchard. The weaker one was so intent upon the apples that she failed to see or hear a boy sitting in a tree house at one edge of the orchard. She moved closer and closer to the tree house, lured on by the tender apples. The boy nervously watched as the deer moved within range of his

brand new shotgun. Local game officials had declared *open season* on fawns, does, and bucks. If the boy succeeded in killing his first deer, it would be legal. He knew his father and mother would be proud of him and eager to have venison for the family table. The open season law had now made man the most powerful predator in the valley. The shotgun was pointed carefully toward the young deer, and her short life ended with a deafening explosion. The boy shouted with joy and excitement and lifted his trophy on his shoulders to carry it home. Tense and frightened, the stronger twin bounded away alone, no longer flanked by his companion.

Winter came hard and fast. In late November, just at breeding time, the blizzards came. Snow fell and drifted into twenty foot mountains. The herd didn't move more than a quarter of a mile that winter. They struggled for the dwindling food supply. Many of the fawns and does died from lack of reachable vegetation. The one hundred deer in the valley were reduced to forty. The surviving twin lived through the severe winter, but not without a price. He was thin and weak. His weight, or *biomass*, dropped from one hundred pounds to eighty. In fact, the total biomass of the herd was sharply reduced from the previous year.

The *biological controls* of disease and parasites thinned the herd further in the coming spring, leaving only twenty deer in the mile-square valley. It would probably be a few years until the land could support a herd of sixty deer again. No one knew what adventures would be ahead for the lone twin during the coming year. Would he live until his second birthday?



Can You Answer These?

1. What types of plants do deer prefer? What will they eat when the more nutritious plants are not available? Find out what deer eat in your area.

2. What was the carrying capacity of the valley when food was plentiful? What was it the following spring? Explain the reason for this change.

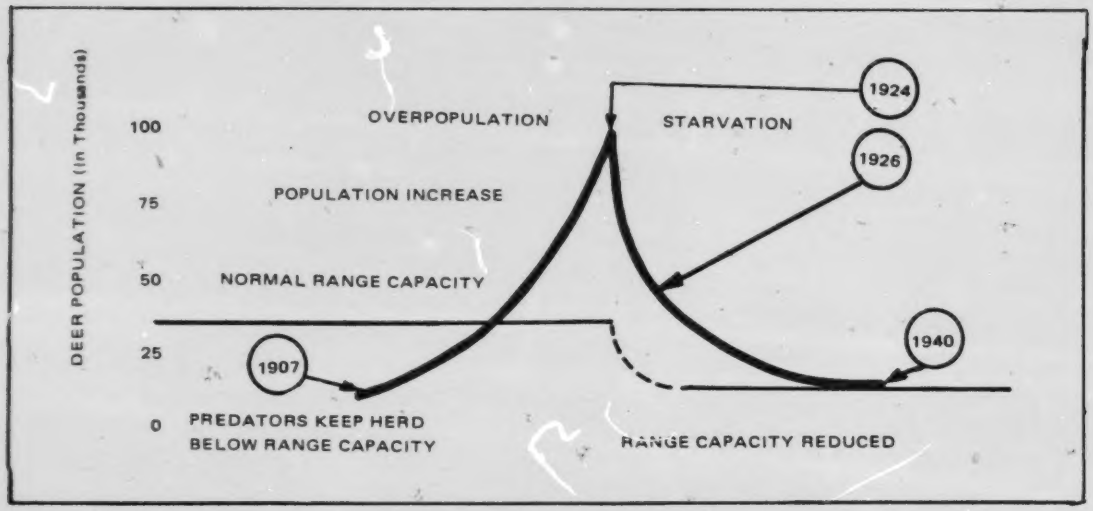
3 How are young fawns adapted for survival? How are does and bucks adapted for survival?

4. In the story, why did the game officials allow people to hunt fawns and does as well as bucks? Find out how biologists count the number of deer in an area. What are the hunting regulations for deer in your state?

What is the Role of the Predator?

Predator-prey relationships abound in nature. Wild dogs, like the pack referred to in the story, often prey upon deer. So do coyotes, wolves, mountain lions, and people who like to hunt. Other people protest against hunting. Some also try to remove predators from an environment, a practice that can do more harm than good. A famous example of well-meaning interference with a predator-prey relationship concerns the deer population that lived on the Kaibab Plateau in Arizona in the early 1900's.

Between 1907 and 1923, people—including hunters who wanted the deer for themselves—killed 3,000 coyotes, 11 wolves, and 600 mountain lions. These animals had all been preying upon the deer population and keeping the size of the herd to about 4,000. The chart shows you the story of what happened. The deer population of Kaibab grew from 4,000 in 1907 to almost 100,000 by 1924. This peak population in 1924 was so far above the carrying capacity of the range that over 50,000 deer starved to death in the next two years.



ECOLOGY: PRINCIPLES AND PROBLEMS

Ecologists study animals to find out how they relate to each other and to their environments. A wildlife ecologist's job is to learn as much as possible in order to help solve some of our wildlife problems. Ecologists believe that helping to maintain a variety of animals on our planet is important. They believe that the health and survival of any one species is related to the health and survival of many other species. Therefore, to an ecologist, wildlife serves as a barometer to warn people of danger. Just as barometers indicate high and low pressures to weather forecasters, what is happening to wildlife may indicate what is in store for us.

An example of this barometer idea is the increasing problem of certain pesticides and how they affect bird species, such as the eagle. As you learn more of what ecologists can teach you about wildlife, you might at first wonder, "How does this affect me?" But soon you will discover how wildlife problems can have an impact on your own life.

Some of the problems which have been studied by ecologists and which still need further investigation are these:

1. What animals are in danger of becoming extinct, and why?
2. Have any threatened species been able to restore their populations? Have people aided the threatened species, and if so, how?
3. Does the paying of money to kill predators help to reduce their populations?
4. Are hunting and trapping ecologically sound practices?
5. Is the use of poison a good tool for wildlife management and predator control?
6. Is it good to introduce an exotic species into an environment?

EXTINCTION, NATURAL AND OTHERWISE

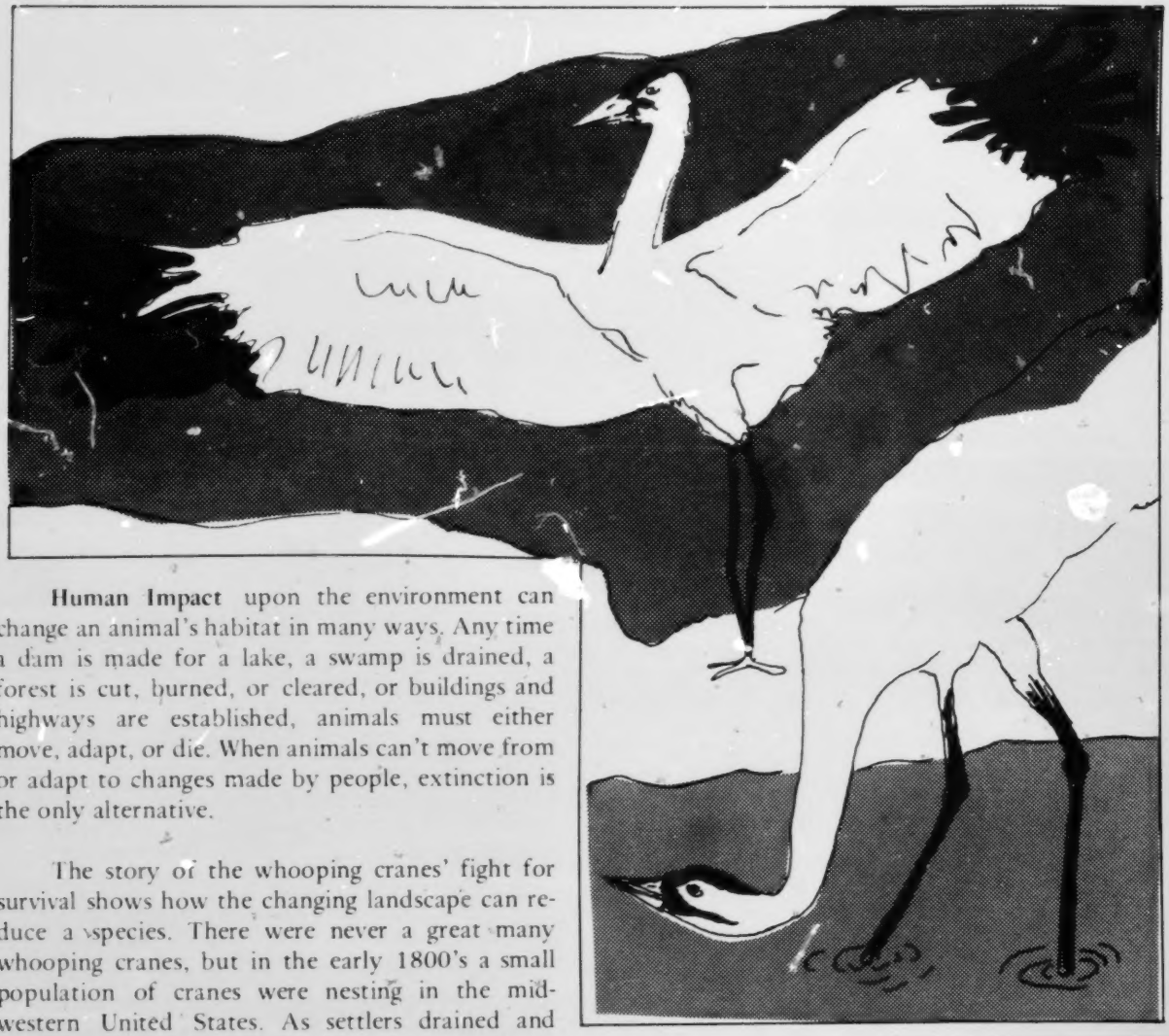
Animal species have been vanishing from the land, air, and water of our Earth for millions of years. Extinction is a natural process caused by changes in environmental conditions over thousands of years. When an animal species becomes extinct naturally, there are usually other animals that can take over its role, or niche. For example, scientists think that animals called marsupials (pouched animals like the kangaroo and the platypus) probably took over the niche as grazers when the grazing dinosours became extinct. The marsupials were later replaced by higher mammals.

Often when people cause or hasten the extinction of a species, the niche remains unfilled. Many such examples can be noted among species which people have caused to become extinct. Nearly fifty species of wildlife in the United States have become extinct in the past 150 years. Of the recorded extinctions of mammals in the whole world during the past 2,000 years, half have occurred within the past fifty years. **The International Convention on Trade in Endangered Species** recently listed 375 species of animals throughout the world as threatened with extinction and another 239 species for which additional trade controls should be established.

Over-Hunting some species for food is one way people have helped to eliminate them. The passenger pigeon and the dodo are two such examples. Once their numbers were reduced below a certain level, they were doomed. Over-hunting has also resulted from people's desire for fur and feathers, for raw materials used in the manufacture of certain products, and simply for sport.

Increased Pollution of the environment is another way that people have threatened animal species. The oceans of the world have been used as dumps for many years. Pollution may eventually eliminate the food sources of many fish, seals, and whales. Pollution also affects fresh water, the air, and the soil. DDT poison has even been found in the tissues of penguins in Antarctica, thousands of miles from where it was originally used.

Competition between people and other animal species for grazing places and food has often caused man to kill off his competitors. For example, grass-eating prairie dogs have traditionally been poisoned or shot when they interfere with the cattle on the range. Other animal grazers have been fenced out or hunted to prevent them from eating grass reserved for cattle. During the 1960's, bighorn sheep in the Rocky Mountains were driven almost to the point of extinction by livestock owners whose herds used the same grazing areas the sheep depended on. The cattle had been allowed to over-graze the vegetation, which meant that much of the bighorns' food disappeared. Weakened by the shortage of food, the bighorns next fell victims to pneumonia brought on by weakness from parasites. One type of parasite had been introduced to the bighorns' habitat by people when they brought their domesticated sheep to the area.



Human Impact upon the environment can change an animal's habitat in many ways. Any time a dam is made for a lake, a swamp is drained, a forest is cut, burned, or cleared, or buildings and highways are established, animals must either move, adapt, or die. When animals can't move from or adapt to changes made by people, extinction is the only alternative.

The story of the whooping cranes' fight for survival shows how the changing landscape can reduce a species. There were never a great many whooping cranes, but in the early 1800's a small population of cranes were nesting in the midwestern United States. As settlers drained and plowed the land, the birds' nesting sites disappeared. Gradually the whoopers nested further and further north.

By the early 1900's, ecologists couldn't determine where the cranes were nesting. They studied one flock as it was wintering in Texas in the 1930's, where the federal government had established the Aransas Wildlife Refuge. The presence of young birds in this flock indicated that the whoopers were nesting somewhere, but where? In 1954, the secret nesting site was discovered in a wilderness near the Arctic Circle. Ecologists had been keeping a count of the rare whooping cranes. They counted eighteen in 1938, thirty two in 1958, and fifty six in 1970.

In 1967, ecologists began to breed the cranes in captivity in case something ever happened to the wild flock. Whoopers were still being shot at as they migrated over the 2,500 miles between their nesting site and the wintering grounds. The fight to increase the flock seems never to be over. In 1970, the dredging of oyster shells from the San Antonio Bay near the 47,000 acre refuge caused alarm to whooper lovers. The dredging stirred up the bay bottom, killing many of the small marine plants and animals which provide food for the cranes. Ecologists pointed out how the dredging affected the giant birds and recommended that dredging for shells near the refuge should be made illegal. The dredging continued, however, until there were no more oyster shells.

COMEBACKS AND CONTROLS

The coming of man to the wilderness does not always end with the extinction of animal species. Some animals have later flourished that once were threatened. The beaver, trumpeter swan, wood duck, wild turkey, and bison are a few once-rare species whose populations have increased in some areas.

The bison, or buffalo, population began to grow again because laws were made to protect them and government lands were set aside for the herds. From a peak population at one time of eighty or ninety million, the bison were later reduced to fewer than a thousand. There are thousands of bison in the United States now, but there will never be eighty or ninety million of them again, because the available supply of bison habitat has been severely reduced. Ecologists must continue to observe the bison herds to determine whether they are multiplying beyond the carrying capacity of the land.

Recently, the bison herd in Yellowstone National Park was in danger because of a bitter argument over a disease called brucellosis. Brucellosis affects domestic livestock and causes milk loss and abortion. It doesn't seem to harm the bison, however. Ranchers were worried that the 700 bison could spread the disease to their livestock if they ever wandered out of the park. The ranchers wanted the infected bison killed to protect their animals.

Ecologists pointed out some of the complexities of the problem. It seemed impossible to round up all of the bison in the park to check for the disease. Even if that were possible, bison become domesticated quickly if they are penned up. The Yellowstone herd would then lose their ability to live in the wild. Another problem is that other animals, including elk, rodents, flies, and ticks could carry the disease. It seemed impossible to kill all of these too.

If the bison were eliminated from Yellowstone, the ecology of the area would be affected. Also, the visitors to the park would not be able to enjoy the sight of these unusual creatures any more. Ecologists told the ranchers that the herds rarely wandered from the park and that the possibility of infection of their cattle was slight. The ranchers to this day are not satisfied because they know the difficulty of trying to control the range of large animals. There is still more work for the ecologists to do. Perhaps some new information about the bison or about brucellosis could help to solve this difficult problem. How would you solve it?

Land Use Control can be a major factor when animal species make a comeback. The federal government is the largest land owner in the United States. Nearly 800 million acres are under federal jurisdiction. About 300 million acres are under the control of agencies such as the National Park Service, the Forest Service, and the Bureau of Sports, Fisheries, and Wildlife. You might like to use the addresses of such agencies, listed on page 36 of this booklet, to obtain more information. The largest area, almost 500 million acres, is under the control of the Bureau of Land Management. The lands controlled by different agencies are maintained or used for various purposes. Wilderness areas, for example, have a great many safeguards to keep them forever wild. It is customary for people not to be allowed to camp, picnic, hunt, swim, or fish in most wilderness areas. But it is legal in other areas such as national forests to cut timber, graze cattle, hunt game, or pursue recreational activities.

Animal Protection Laws have sometimes been passed in time to help save threatened species, but at other times laws have appeared too late to do any good. Laws intended to save a species threatened with extinction have usually limited or eliminated the hunting of that species. Laws were once passed for the protection of the now extinct heath hen and the passenger pigeon, but these laws came too late to save them. Today, ecologists try to anticipate sources of future trouble and then work to get good laws passed in time.

BOUNTY HUNTING

Bounty hunting, which is the killing of certain animals to get money as a reward, has been going on since 1683 when William Penn paid for dead wolves. Bounties at one time or another have been paid for foxes, hawks, owls, crows, ground squirrels, beaver, bob cats, blue jays, starlings, and many other large and small animals. Some people believe that predators should be reduced by bounty hunting in order to be less annoying to people, less destructive to domestic animals and crops, and less competition in the hunt for game animals for meat or sport.

Most ecologists challenge the value of the bounty system. They have pointed out, for example, that despite the bounties on Pennsylvania foxes which have been in effect for many years, the foxes have still increased in number. Ecologists also affirm that killing predators has little effect on the populations of species which people like to hunt. Predators play an important role in removing the weak and diseased animals of a population, animals which otherwise would die slowly or even cause healthy animals to become ill. But the chief argument against bounties is that animal populations seem to rise and fall in cycles, and bounties have little overall effect on these natural cycles. In 1972, twenty three states still paid bounties for certain animals. Are there bounties on any animals in your state today?

HUNTING AND TRAPPING

Hunting and trapping have been criticized by some people who believe it is cruel to kill animals. Others who support hunting say it is a useful way to control animal populations, and they are convinced that more animals would die of starvation, disease, or predation if they were not hunted or trapped. They also say that hunting and trapping have economic and sport values.

The pros and cons of hunting and trapping should be discussed only as they apply to specific animal populations in specific environments. Ecologists should study an animal population and its habitat and then pass on information to law makers before it becomes legal to hunt that population. Details about an animal's reproductive potential, its food habits and *territory*, and the present carrying capacity of its range must all be studied. Ecologists should evaluate all the population factors of the species and its environment. Then the question of whether hunting or trapping should be allowed can be answered, and an ecologically sound game law—if there is to be one—can be written. It is also important to change the game laws when changes occur in the populations of hunted species or in the conditions of their environments.

POISONING

The practice of poisoning to control wildlife, pests, or predators must be carefully examined. If a poison can travel through a *food web* and affect the environment in a harmful way, the use of that poison must be stopped. The harm of the poison must be weighed against the benefits of controlling the animal in question and a decision made for each situation. In 1972, the federal government banned the use of toxic chemicals in the predator control programs that were conducted on federal lands. The issue may be restudied in the future and the decision may be changed. Where do you stand on this issue?

In many areas industrial pollution has poisoned the water supplies that wildlife and people depend upon. One of the toxic waste products of industry is mercury (methylmercury). In animals, mercury poisoning can cause brain damage, convulsions, blindness, or death. It can cripple or kill unborn young also. The chart below identifies the major sources of this pollutant in our environment today.

Sources of Mercury Pollution

26.56%	Chemical products (such as caustic soda and chlorine)
23.91%	Electrical apparatus (switches, thermostats, batteries, etc.)
12.74%	Processing of products such as thermometers
8.94%	Industrial and control instruments
3.91%	Dental preparations
3.79%	Catalysts for manufacturing
3.44%	Agriculture
2.61%	General commercial laboratory use
.92%	Pharmaceuticals
.71%	Paper and pulp manufacture

EXOTIC SPECIES

If you asked an American hunter's opinion about bringing the pheasant into this country, he might say it was a good idea. If you asked a forester about allowing the gypsy moth to escape, multiply, and eat tree leaves, he would probably say that it was a mistake. If you asked a fisherman about the introduction of brown trout into this country, he would probably approve. But then if you asked a bird watcher about the introduction of English sparrows and starlings into the United States, he might shake his head in disgust.

The important question for ecologists to answer before it becomes legal to release any *exotic* species within the United States is: What effect will it have on the ecology of the area where it will make its habitat? The total impact of any new species upon the living and nonliving things which comprise an environment must be understood first.

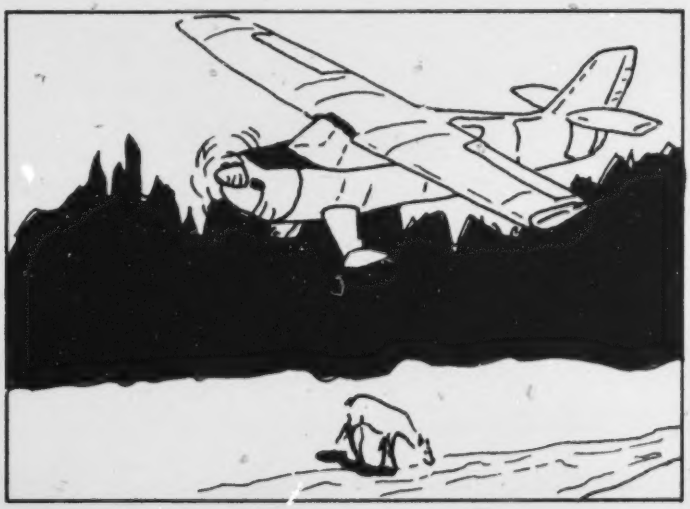
SUMMING UP

Look again at the six questions listed on page 14 of this article, **ECOLOGY: PRINCIPLES AND PROBLEMS**. Have you formed any opinions or answers by reading the article? Would you like to do some research to get good answers to the questions?

If you have not used Activity Cards 1 through 7 as yet, you may find them of interest at this point in your study. As you read the next two articles in your booklet, Activity Cards 8, 9, and 10 will give you more opportunities to make investigations.

THE TOOLS OF WILDLIFE MANAGEMENT

*The main goal of wildlife management is to assure healthy and productive wildlife resources despite rapid changes in land use and the growth of the human population. Ecologists use these five management tools: **(1) Inventory, (2) Maintenance, (3) Improvement, (4) Restoration,** and **(5) Proper Use**. In order to answer the many difficult wildlife management questions, ecologists must carry out continuous research programs which put these tools into action.*

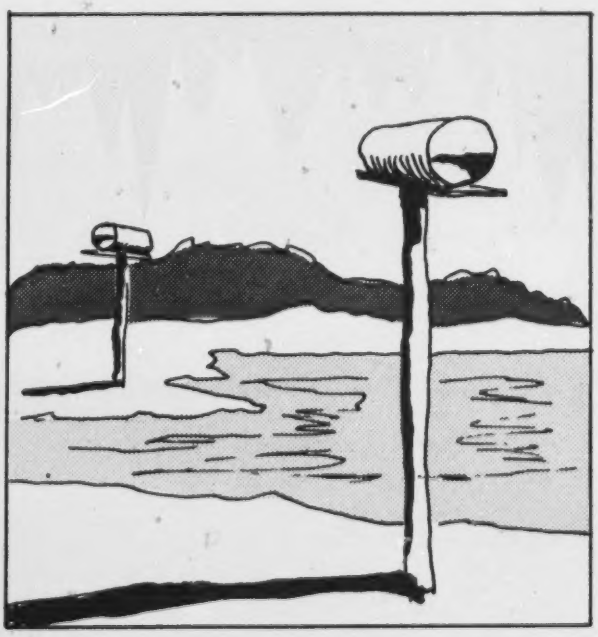


Maintenance

Constant maintenance of animal populations is necessary because of threats from overpopulation, competition, disease, and poor land-use practices. Even though wildlife managers understand the importance of predators, it is sometimes necessary to control their numbers. For example, they sometimes trap and kill individual predators that have been identified as killers of nearby livestock, while letting others of the same species continue their role in nature's system of checks and balances. When certain lakes become overcrowded with fish, the stunted fish are removed to make the waters productive again. If disease breaks out in an animal population, wildlife managers try to check the spread and find ways to prevent the disease from occurring again. In times of severe weather, it is sometimes necessary to provide emergency winter feeding programs for some animals. Wildlife managers regard all these practices as temporary measures which should not be continued over long periods of time.

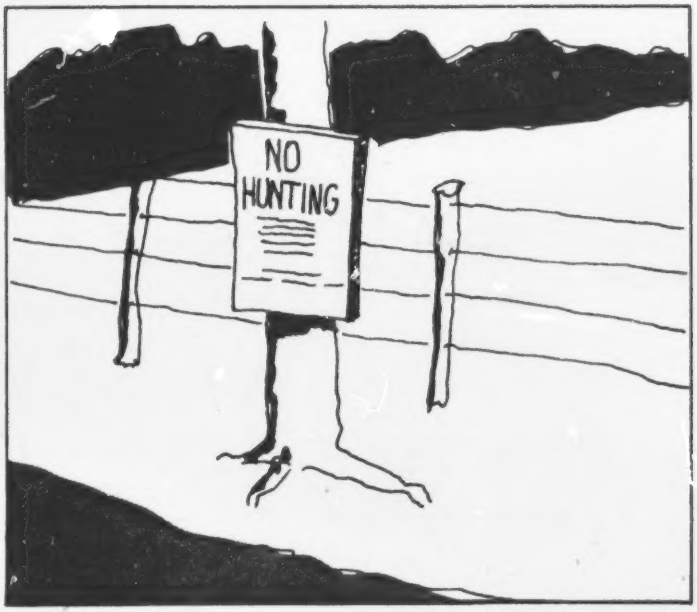
Inventory

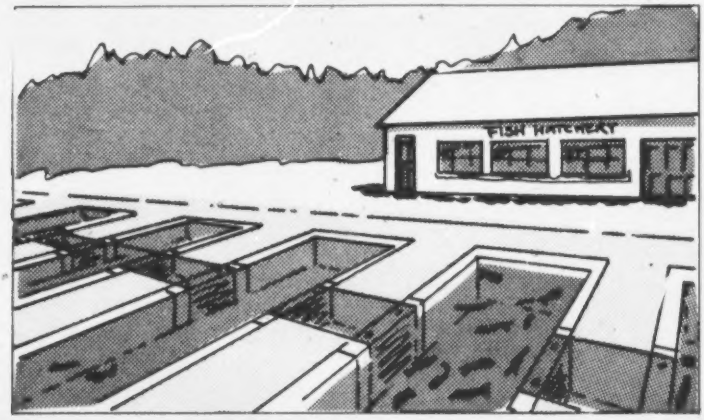
Wildlife managers must know what animals are "out there" and what conditions they are in. First, census taking involves actual counts or partial sample counts of animal populations throughout the year. Second, a wildlife manager has to know how many new animals are being added to the population each year. Third, he must know how many animals are being removed from the population annually due to hunting, disease, starvation, or other limiting factors. Some sampling techniques include: **listening for mating calls, taking a count** from an airplane, **looking for signs** such as homes and scat (animal droppings), **live-trapping, fish-shocking,** or **asking for wildlife information** from farmers and hunters. You might like to try a population sampling activity. There is one provided for you on page 32 of this booklet.



Improvement

The improvement of conditions in the total environment to encourage better growth and reproduction of wildlife is a big job. Building a farm or forest pond is one way to increase both the populations of fish and the populations of animals that eat fish. Supplying the missing elements in poor habitats or removing undesirable elements is another wildlife management practice. For example, a wildlife manager might in one season set out food for deer and in another season allow hunters to kill a certain number of deer. He might even plant an area to attract a type of insect that is known to feed on a type of insect whose population he wishes to eliminate or reduce. (This practice is known as *biological control*.) A wildlife manager will study a habitat carefully before he recommends any improvement plans.





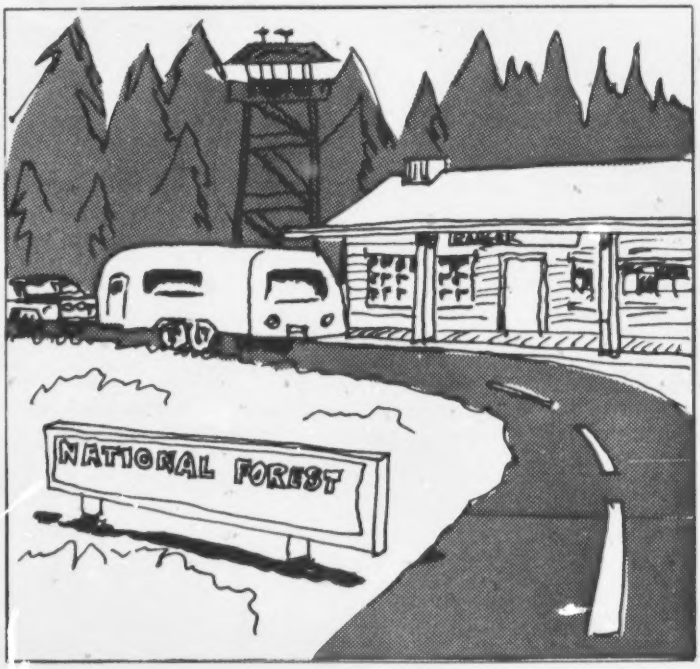
Restoration

Some species of animals such as pheasant and trout are raised in captivity and then released for sportsmen and nature observers. This practice usually increases the natural populations of such animals only for a short time, because they are soon harvested with guns or fishing rods. Also, if adequate food, water, cover, and living space are not available where they are released, the stocked animals could not survive to reproduce anyway.

Proper Use

There are many uses made of wildlife. Recreational enjoyment of wild species is a big interest today due to increased leisure time and people's outdoor activities. The challenge for the wildlife manager is to maintain adequate wildlife populations for as many segments of our population as possible. Protected lands, good laws, and enforcement procedures do help to assure proper use of wildlife resources.

Wildlife management involves the use of different tools and procedures in many different habitats in the United States. Wherever animals live, however, they all need the basics of food, cover, water, and living space. It is the job of each wildlife manager to see that these needs are met. Can you think of ways that you could cooperate with wildlife managers in order to help them do a good job?



A KEY CONTROVERSY: LAND USE

FACTS ON LAND USE IN THE UNITED STATES

To define and achieve good use of land may well be the most fundamental of all environmental objectives. In the broadest sense, the way in which we use our land determines the way in which our society functions. Land is the basic source of our food, fiber, shelter, water, and oxygen. Sound land use is fundamental to the political, social, and economic structure of our society. *

1. The total land area in the United States is approximately 2,266 million acres (including wetland areas such as marshes, swamps, river flood plains, streams less than 220 yards wide, and lakes, reservoirs, and ponds less than 40 acres in area).

2. Cities, roads, and airports represent 3 percent of our total land area. Another 3 percent represents park and regulated open areas. 22 percent of the total land area is crop land, 32 percent forests, and 34 percent grazing land. The remaining 6 percent represents wetlands and small bodies of water.

   Using the information in items 1 and 2, can you compute the number of acres there are in each percentage?

3. The acreage figures for land use are always changing. In 1963 it was estimated that over 1 million acres of United States land had been developed for various purposes. Another way to express this figure is that the United States was using up 3,333 acres of open space for some type of development each day all year during 1963. The pattern of consuming open space for development purposes has continued to today.

4. Land is used for many purposes. Here are a few: farms, grazing, forests, historic sites, water supply, industry, homes, recreation, cemeteries, military reservations, and transportation. What other land uses can you add?

5. The National Park System occupies about 30 million acres of land. State and local parks and forests occupy about 40 million acres. In 1925, 5 million people visited the National Forests. In 1967, 150 million people visited the National Forests. Attendance at our National Parks has increased 8 to 10 percent each year since 1910. Can you imagine how many people visited the National Forests and National Parks last year?

6. Between 1800 and 1972, the population of the United States increased from 5 to 210 million. During 1973, the growth rate was a low 7/10 of one percent. If this low rate continues, there will be an estimated 250 million people in our country by the year 2000. Each one will require the life-support systems of the land. What do you think the carrying capacity of the United States will be for 250 million human beings in the year 2000?

* Quoted from THE PRESIDENT'S COUNCIL on ENVIRONMENTAL QUALITY, January, 1975.

Land use practices and policies are being discussed throughout our country today. Three of the issues are these:

1. *Development of the floodplains.*
2. *Urban consumption of open space.*
3. *Use of open space as a natural resource.*

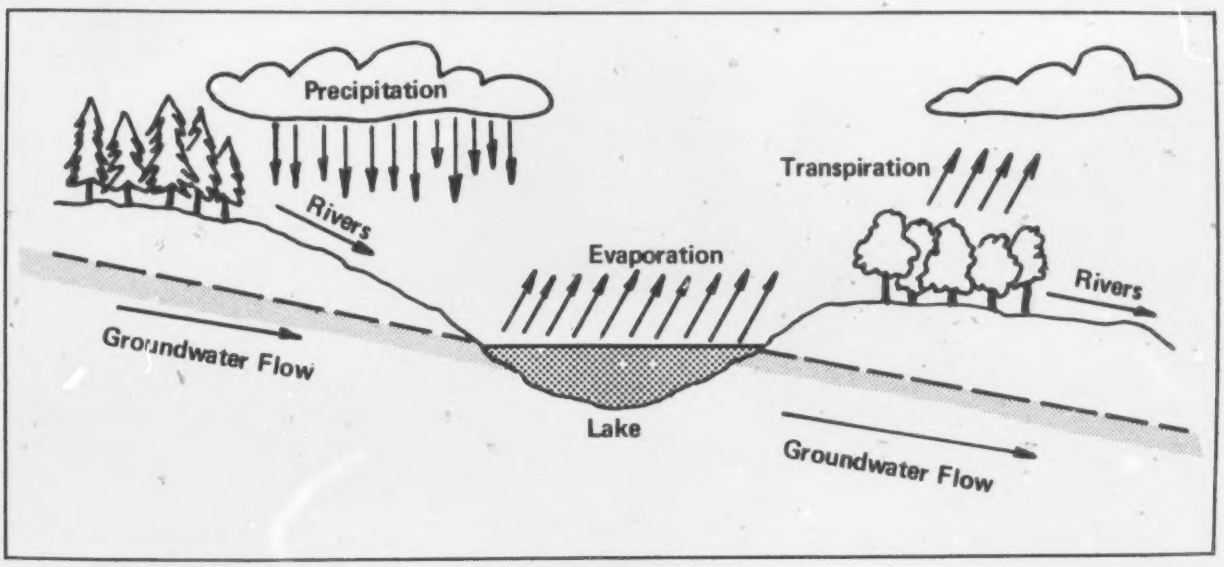
Floodplains

Knowing which lands to develop for man's use and which to leave as open space has been a major problem as our urban areas expand. In the past foolish decisions have caused inconvenience and great expense. A typical example of unwise land development has occurred on many of the low plains along rivers and streams.

Floodplains are formed over thousands of years from flood waters which deposit mud along both sides of a river or stream. The flat areas nearby are called floodplains. When heavy rains or melting ice and snow cause a river to flood, the water races down an area within the floodplain called the floodway. The floodway is the area where the current is fastest and most capable of washing away almost anything in its path.

Ever since man first started selecting places to live, these floodplains have been chosen because the land is fertile and flat, the air is cooler near the water, and clean water and the surrounding valleys are both beautiful and useful for transportation and recreation. In the early days when floods came, man could easily rebuild what was washed away and continue to use the land. But when flood waters cause damage to our more permanent buildings, it costs a great deal to replace or restore them.

Because of the damage to man-made structures by floods, it might be better to leave floodways and sections of floodplains as open space. Man can never fully eliminate the natural process of flooding. He can, however, use wisdom in developing some lands and leaving floodplains for other uses.



Annual rainfall in the United States averages 5 trillion gallons a day. There are great variations in the amount of water that returns to Earth in each rainfall. Each time, some water evaporates immediately. The greatest amount finds its way into the underground water system, and the rest is absorbed by the soil and by plants in the soil. Although floods and droughts are extreme events in nature, they do occur. Where in the diagram do you think it would be unwise to plan to build houses?

Urban Growth

When open land is developed and used in such a way that its naturalness is destroyed, it is called a consumptive use of the land. Some consumptive uses are for industry, housing, and waste disposal. Other uses which do not convert open space to developed land are called nonconsumptive. Some nonconsumptive uses are for park development, wildlife refuges, national forests, and for recreation activities such as swimming, hiking, skiing, and camping.

Most of the problems of land use occur in or near urban areas. Although only about one percent of the land area in the United States is urbanized, over 70% of the population lives there. Problems usually arise when electrical companies propose a generating station in a scenic area, when highways threaten to replace hiking trails, when parking lots are planned in parks and green spaces, when swamps are in danger of being drained, or when old trees are challenged by a chain saw.

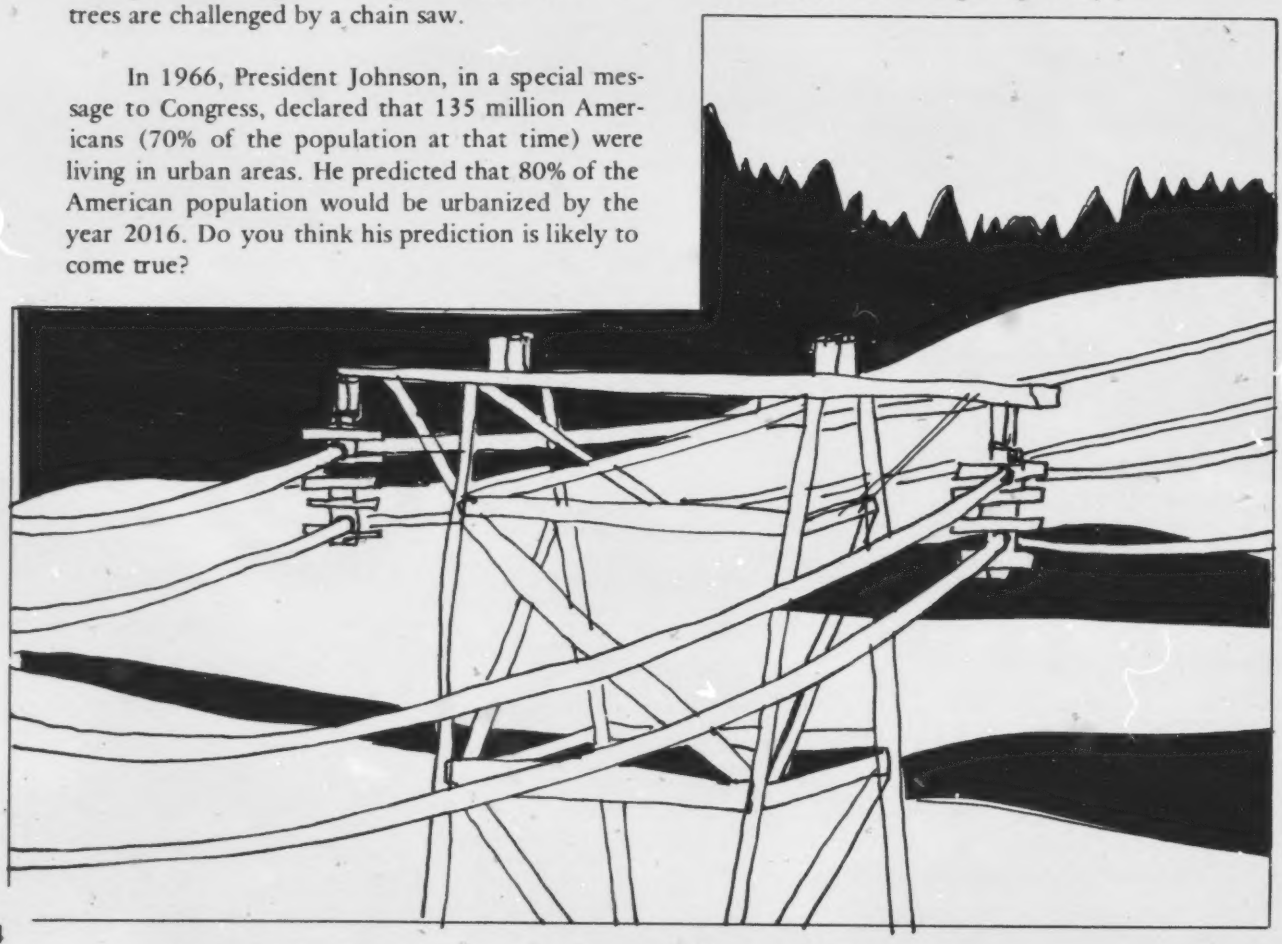
In 1966, President Johnson, in a special message to Congress, declared that 135 million Americans (70% of the population at that time) were living in urban areas. He predicted that 80% of the American population would be urbanized by the year 2016. Do you think his prediction is likely to come true?

Urban Environmental Problems

1. Every urban area of the world has serious air pollution problems. Pollution cuts down the amount of sunlight that reaches New York, for example, by 25% and Chicago by 40%. Air pollution from urban industrial areas and especially from transportation destroys $500,000,000 or half a billion dollars worth of crops every year.

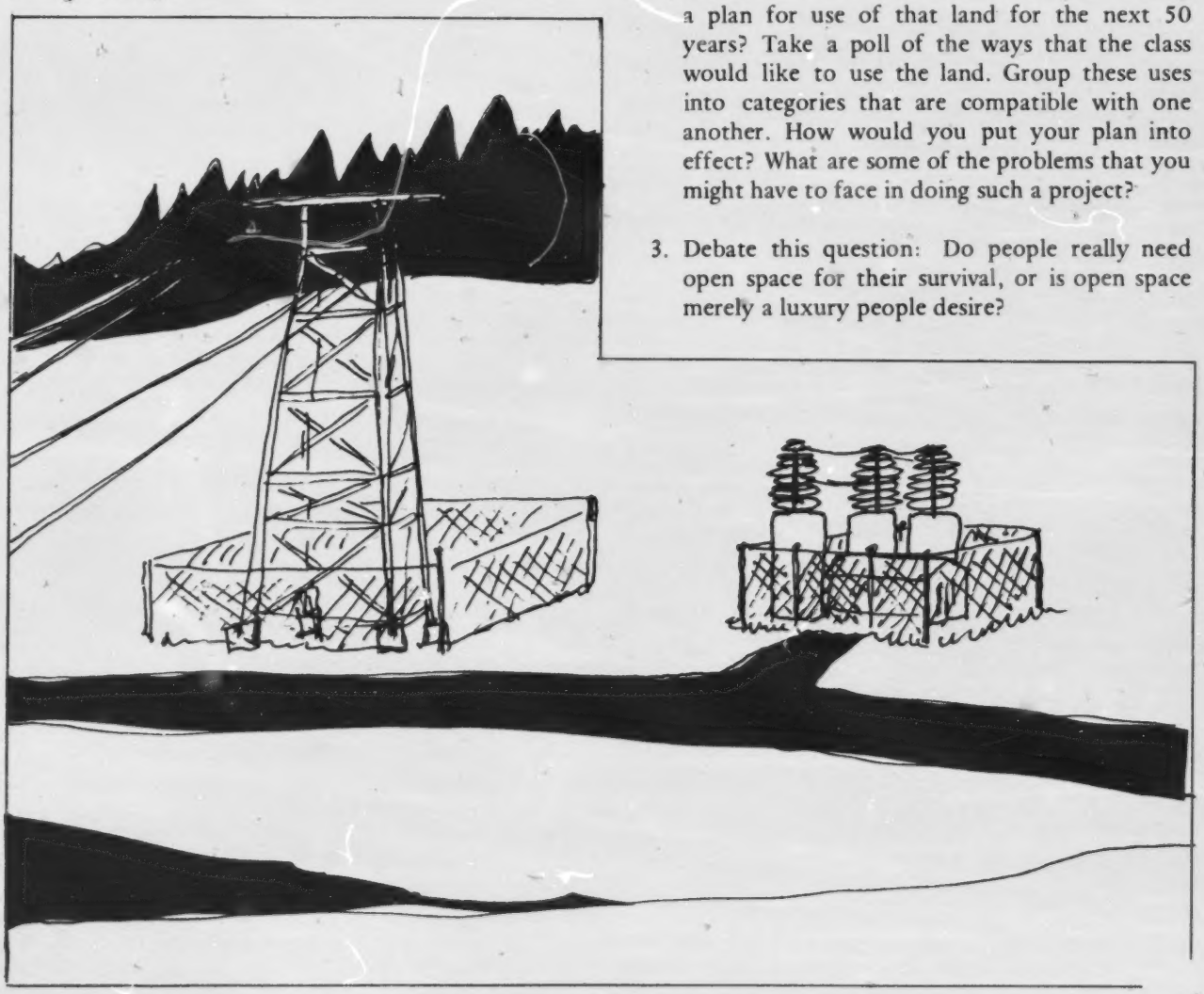
2. The more people there are in a watershed, the less chance there is of having enough water fit to drink. As the populations of urban areas grow, their sewage treatment facilities are often quickly outgrown, and industrialization too often discharges pollution into the waterways.

3. In 1970, the Department of Health, Education and Welfare branded 94% of the disposal sites of urban areas as "environmentally unacceptable." Urban areas cause more than 70% of all the solid waste and garbage every year.



Open Space Resources

Open space should be considered a natural resource that is as important as coal, iron ore, or timber. It can be preserved in places that will most benefit man. State or federal governments could buy land and sell it with the provision that some open space must be preserved as the land is developed. Another method would be for individuals or groups to purchase conservation easements. An easement is a land right that can be purchased—not the land itself. For example, purchasing a scenic easement guarantees that the owner will not erect any structure or object that will interfere with the scenery. Zoning is another method of limiting development to certain areas. In some cases, such as on certain floodplains, an area could be zoned for no development.



Sharing Your Ideas

1. If you were forced to live alone in a wilderness area hundreds of miles from the nearest town, could you survive until help came? List as many ways you know to obtain drinking water, food, shelter, fire, and clothing. What would you do to occupy your time? What could you construct from your surroundings? What would you most want from civilization? How would it feel to be totally alone? Would you be hungry, thirsty, cold, or bored? Compare your ideas on how to survive in this situation with the ideas that the rest of your classmates might have.

2. If your class earned enough money to buy 40 acres of undeveloped land, what type of land would suit the class members? Can you develop a plan for use of that land for the next 50 years? Take a poll of the ways that the class would like to use the land. Group these uses into categories that are compatible with one another. How would you put your plan into effect? What are some of the problems that you might have to face in doing such a project?

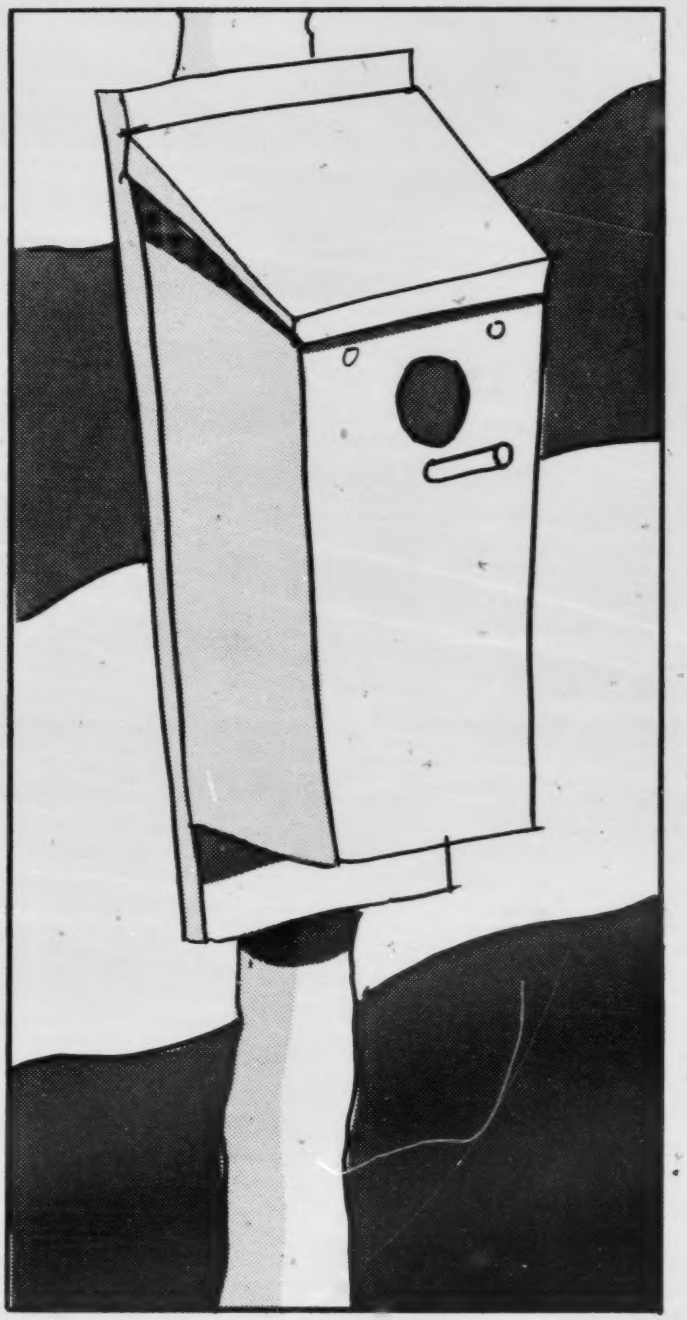
3. Debate this question: Do people really need open space for their survival, or is open space merely a luxury people desire?

HELPING A THREATENED POPULATION: A MODEL FOR ACTION

*During the last 150 years, more than 200 dramatic and colorful species and subspecies of mammals, birds, and fish have disappeared from the face of the earth—nearly 50 species in America alone. At least 100 more are endangered in this country, and on the International "Danger List" a shocking 1,000 species are identified as facing extinction.**

Identifying a Problem

A few years ago the Science Club of an Illinois school started a project aimed at increasing the bluebird population. The problem facing this species is that their numbers are decreasing. Other animal species such as the whooping crane, the bald eagle, and the alligator are in similar plights, threatened by possible extinction. The impact of man on the natural community has often worked against the survival of other species.



The club members, aware of the threat of bluebird extinction, wanted to do something about it. Some of them had experienced the satisfaction of seeing the flash of vivid blue of the male bluebird and hearing its song. Others knew that the bluebird ate insects destructive to crops. Still others just wanted to preserve the species because they wanted to know it was there and felt that it had every right to share existence on Earth with man.

Researching and Developing Strategies

After the club members had identified the ecological problem which they wanted to work on, they did research to find possible solutions and mapped out a plan. Supplying bluebird boxes, they learned, was one proved method for helping to increase this population. They obtained plans for construction of the boxes and directions for putting them up. Plans were next finalized for building thirty of the nesting boxes in the school shop.

Constructing the Boxes

As the project progressed, the club members could see how the construction, design, and directions for erecting the boxes related to ecological principles and to the behavior of bluebirds. Important questions were considered, and many hypotheses were made at each step along the way. It was

* Letter from Roger Tory Peterson, member of the World Wildlife Fund, Washington, D. C., April, 1972.

found that the size of the entrance hole was important. A diameter too small would not allow the bluebird to enter. One too large would allow the larger and more aggressive cavity-nesting birds to enter. The distance of the hole above the floor of the box was also important to allow for the exit of the young birds. The color and type of paint affected the temperature inside the boxes, and the wrong paint could cause dangerous fumes. Ventilation and drainage openings, the students discovered, had to be considered as well as the available floorspace inside the boxes.

Setting up the Boxes

The question of the recommended height above the ground was debated because of conflicting figures obtained from different sources. For example, some references recommended that the boxes be placed 100 feet apart, and others recommended 200 feet apart. The students further investigated the purpose of spacing the boxes and found that the bluebird stakes out a *territory* and will not nest close to others of his own kind.

The students considered other questions as they decided upon the right location for each box. Should it face a particular direction? Should it be nailed to a tree? Should it be placed in the sun or in the shade? Many of the students gained a deeper respect for scientific experimentation.

Survey and Study of Occupancy and Behavior

During a field trip the next spring, the students conducted surveys to determine how many of the boxes were occupied by bluebirds. They found out that other occupants such as mud daubers, wasps, cockroaches, spiders, and even mice had been using the boxes for shelter. Boxes containing bluebird nests were carefully examined. The nesting materials were listed and the nest construction described. The presence, size, and number of eggs were recorded.

Those boxes which had bluebird inhabitants were checked periodically to determine the growth and development of the young. Observations were made to study the behavior of the parent bluebirds during the feeding of the young birds. Students discovered that the male and female fed the young at varying intervals. With the aid of binoculars, they were able to determine the diet of the birds and estimate the percentage of each type of food in the diet. They discovered that bluebirds ate huge quantities of beetles, grasshoppers, moths, roaches, and caterpillars. They also found that the parents remove the droppings of the young birds from the nest in order to maintain a clean environment for them.

Preparing Summary Reports

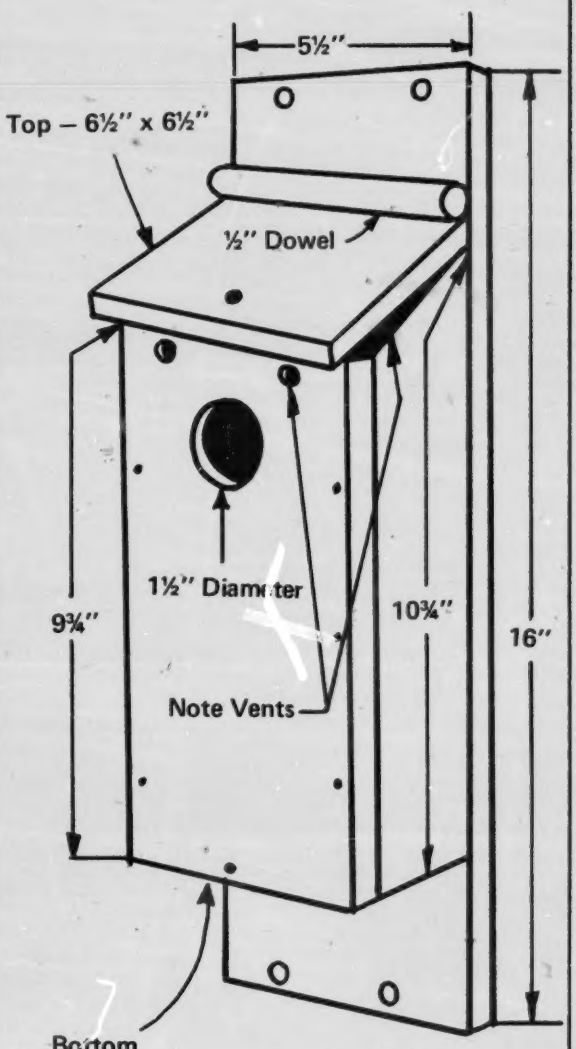
The students' written reports revealed that they had learned many concepts and had applied scientific skills. Another value of the project, and perhaps a lasting and important value, was the development of student attitudes and values toward science and the application of scientific thinking to environmental problems.

Conclusions

This project provided an opportunity for students to attack a problem which concerned them. The project included both indoor and outdoor activities. The students were successful in helping to increase the bluebird population for a period of a few years, and they felt the satisfaction of doing something about the environment rather than just reading or talking about it.

Involvement in any action project, such as the one described in this story, will reveal to you the importance of carefully researching your topic and then developing strategies to achieve your goals. When this project was started, the students had not anticipated all of the problems they encountered along the way. By working together, they accomplished their goal, and they became more environmentally aware in the process.

BLUEBIRD HOUSE



Boards are ¾" thick. Inside surface of front piece should be made rough. Paint a light color.

SUGGESTED STRATEGIES FOR ACTION

1. Take a hike on some open space land. With a compass, follow a direct line from one place to another. A map of the area will help you set the compass direction. As you hike take notes on the evidence of man and the physical terrain. Record such things as fences, hedgerows, homesites, crop land, rock outcrops, vegetation cover, evidence of water, and type of soil.

2. Mark off measured areas of one square meter in different plant communities to compare the types of plants, amount of bare ground compared to the amount that is covered with vegetation, amount of base area of each plant compared to the area covered by the foliage. Note the amount of moisture present, soil compactness and the rate of water absorption, and air movement for each area. Keep a record of the information you obtain.

3. Take a census count of various animals in your area. For example:

   - When snow is on the ground, count the animal tracks crossing a road or path to estimate the number of animals.
   - Count the number of squirrel or bird's nests in a measured-off area. Keep records over a number of months and years.
   - Estimate the number of stray dogs and cats in your area by walking the streets in a regular pattern. An area of town can be divided so that the students in the class can each take a different route.

4. Sketch a map of the vegetation in an area. Using this map, record where the greatest variety of animal evidence is found. Note where common birds are found most of the time. Record the distance above ground for birds, squirrels, and other animals. Include insect life in your survey. If the insects themselves cannot be found, include evidence of insects. What conclusions can be drawn about the relationship of animal life to type of vegetation?

5. Set up an experiment to determine which baits are favored by certain animals. Study mice, pigeons, song birds, squirrels, and other local animals. Can you determine which animals are eating which bait?

6. Select an area and get permission to improve it for certain types of animals. (Remember that improvements for some type of animals will not be improvements for other animals.) Consider food plantings, water sources, shelter construction, and other ways of improving animal habitats. For example:

   - In an area of woods or fields, build piles of branches into a mound at least five feet high and six feet in diameter. Brush piles provide protection for small animals such as rabbits, mice, and other rodents.
   - Place pieces of wood, linoleum, or heavy plastic on the ground. After a few weeks, small animals will occupy the area underneath. You may find centipedes, millipedes, sow or pill bugs, ants, mice, or other animals which favor dark, moist habitats.
   - Plant certain plants to attract birds. Seed-loving birds will be attracted to some of the following plants: marigolds, zinnias, sunflowers, blackberries, clover, oats, rye, wheat, and many other plants.
   - Set up watering stations for birds by securing garbage-can lids or other containers so they will hold water. Notice what other types of animals will stop for a drink.
   - In the spring set out various nesting materials for birds. Prepare materials such as string, yarn, human hair, paper shreds, or pieces from an old broom. Count the number of pieces set out so you can determine which ones are taken.

7. Go on a scavenger hunt and find evidence of animals and plants which fit into the following categories: decomposer, producer, first level consumer, second level consumer, evidence of predator and prey relationship, and animal adaptation. Add other categories to this list.

8. Obtain a land capability survey from a farmer or agricultural agent. Try to determine why particular areas are classified as they are. Make your own classification map of an area if you are unable to find a survey. For further information write Soil Conservation Service, 14th and Independence Avenue, S. W., Washington, D. C. 20250.

9. Join a conservation club with others of your own class or school. One such club that is already organized is:

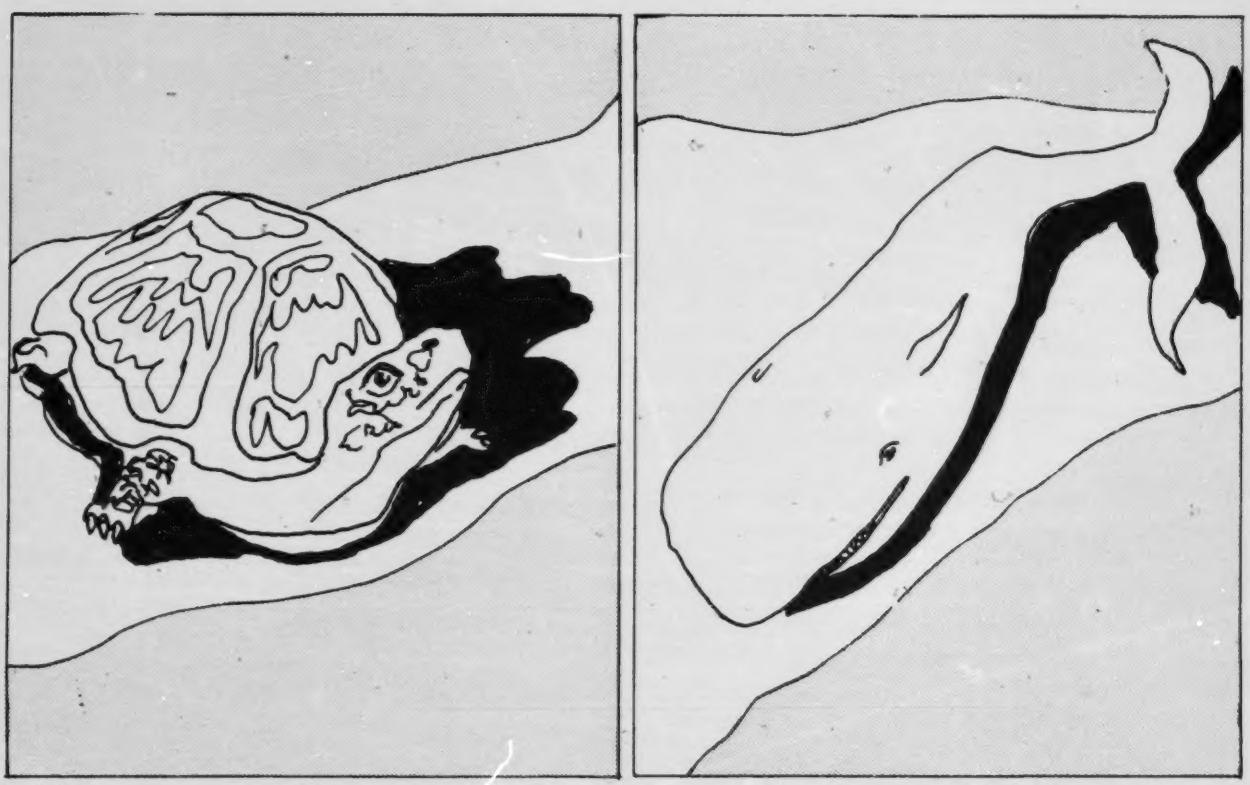
Kind
The National Humane Education Center
Waterford, Virginia 22190

"Defenders"	ages 11–14
"Ecolokind"	ages 15–18

Dues $2.00 plus $.10 per student to enroll in a class club. Some purposes are to protect animals, defend nature, restore ecological balances, and preserve the Earth.

10. Hold debates to discuss the following questions:

- Should we try to find types of controls other than chemical pesticides?
- Should pests such as mosquitoes be eradicated completely?
- Should wildlife be fed during the winter if their food supply runs out?



What law protects these animals . . .

11. Know the laws that protect animals and practice citizen awareness to make sure that the laws do the job they are supposed to do. Most federal regulations and laws for wildlife protection are the concern of the **Fish and Wildlife Service** of the **Department of the Interior**. The Service enforces laws like these:

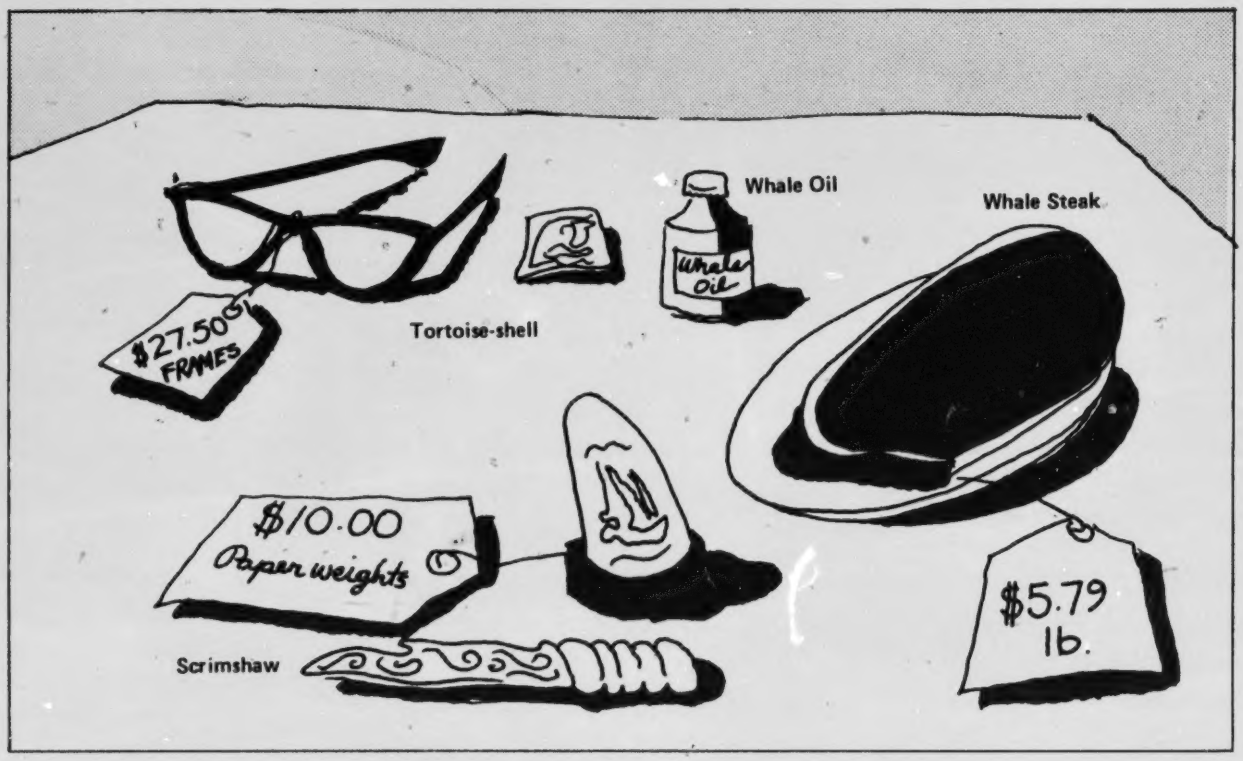
Migratory Bird Treaty Act Anyone seeing waterfowl being shot out of season, hawks or owls being hunted or used for target practice, or songbirds being shot at by BB guns should report a violation of this Act. The treaty is held and enforced by Canada and Mexico too. Also, no items made from the feathers, claws, or beaks of birds—such as gadgets for sale in souvenir shops—can legally be offered for sale.

Public Law 92-159 Shooting of wildlife from aircraft was made illegal by this amendment to the Fish and Wildlife Act of 1956, except by permit for emergency predator control conditions.

Endangered Species Conservation Act of 1969 If you find a store selling any items made from an animal on the official list of endangered species, you should report it to the Secretary of the Department of the Interior. For example, animal skin rugs or belts and tortoise shell combs or eyeglass frames can not be sold legally. The law also prohibits pet foods and articles of clothing made from the whale or the alligator.

Marine Mammal Protection Act of 1972 The sea otter, walrus, polar bear, manatee, seal, sea lion, dolphin, porpoise, and whale can not be hunted either for sport or captured for any purpose.

The Lacey Act of 1900 and Amendment of 1969 These guidelines prohibit both the importation of exotic species without special permit and the shipping, transporting, selling, or buying of any game animal out of season.



. . . from this?

APPENDIX OF INFORMATION

ESTIMATING INSECT POPULATIONS

Ecologists need to be able to estimate populations of various types of living things being studied. One way to estimate the number of insects in a field is by using a method called *removal sampling*. This method makes use of a net for removal of the insects in an organized way.

Locate a fairly large field or open area to sample. Vacant lots, school ground play fields, or parks usually have suitable areas. Mark off a rectangle with string tied to stakes in the ground. If the area is large enough, mark off a rectangle of at least 5 yards by 20 yards (or a square of 10 yards by 10 yards) in order to have at least 100 square yards in which to work. With insect net in hand, walk over the area in a crisscrossing pattern. As you walk, sweep the net through the vegetation just above the ground. Be sure to count the number of sweeps you make during this first coverage of the area.

Record the number of sweeps. Gather the captured insects from the net and place them in a large plastic bag or insect killing jar. Label this collection, "first removal sample." If you want to keep the insects alive to be released later, the plastic bag can be placed in a refrigerator for a few hours to slow down the insects' body processes. This will allow you to count the insects. Keep records of the numbers of the same types such as grasshoppers, ants, flies, beetles, bugs, etc. Repeat the sweeping procedure, covering the marked-off area using the same number of strokes. Do this at least a total of seven times. Label the collection of insects each time, "second removal sample," "third removal sample," etc. The number of each insect type captured should decline after each sampling. Make a chart like the one in Figure 1 using your totals for each type. The numbers in Figure 1 indicate the number of plant bugs captured by using the removal sweeping method.

Find out the number of sweeps it takes to cover one square yard in your sample area. (Divide the total number of sweeps by 100 square yards to find this.) For example, if it takes 200 sweeps to cover 100 square yards, it would take 2 sweeps to cover 1 square yard ($200 \div 100 = 2$). Once it is known how many sweeps it takes to cover one square yard, you can compute how many it will take to sample the insect population of a larger area. For example, it would take 400 sweeps to sample an area of 200 square yards ($200 \times 2 = 400$ sweeps).

Set up a graph and plot these numbers as shown in Figure 2. If the points on the graph follow a fairly straight line, you can be almost certain that you are decreasing the insect population in a systematic way. By connecting the points with a line and extending the line to the zero point, an estimate of the total population of each insect type is made. In Figure 2, the line crosses the zero point at approximately 300. This is an

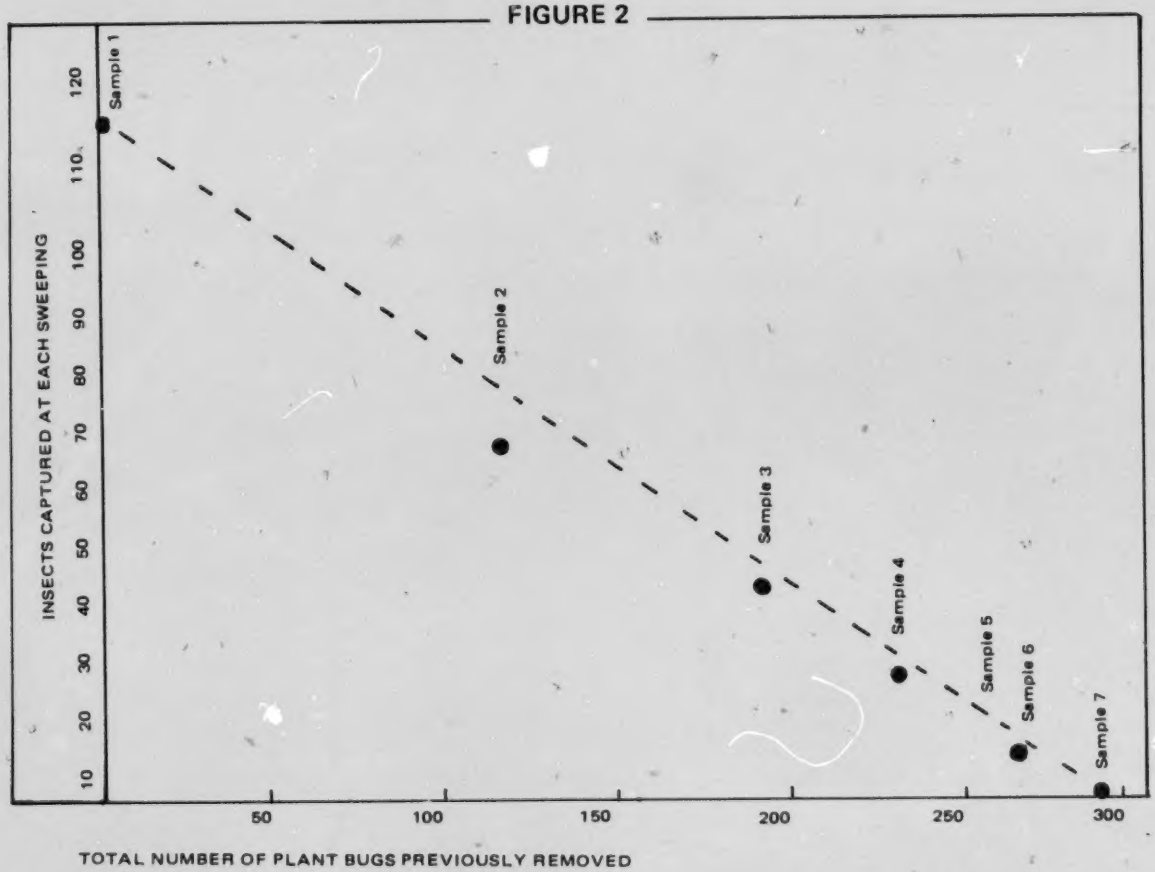
Sample	Type and Number Captured	Number Previously Removed
1	115	0
2	67	115
3	42	182
4	27	224
5	18	251
6	16	269
7	10	285

FIGURE 1

estimate of the total population if all of the bugs could be removed from the area.

For some types of insects you collect, the points on the graph will not fall in a straight line. This could mean that the chances for capturing that type of insect vary each time the area is sampled. Perhaps one type of insect flies away or drops to the ground after the first sampling. Try this for a number of different insect types and determine when this method works.

FIGURE 2



ECOLOGY GLOSSARY

The ecology terms which have been italicized in the articles of your booklet are defined for you in Section 1 below. The key words and concepts of the audio-visual materials of the unit are defined in Section 2.

SECTION 1

1. **ADAPTATIONS** any changes over a long period of time in the structure or the functions of an organism which enable it to be better adjusted to its environment.

2. **BIOLOGICAL CONTROL** the control of populations of animals by predators, parasites, and disease rather than by mechanical or chemical means.

3. **BIOMASS** living matter expressed in terms of weight.

4. **CARRYING CAPACITY** the number of animals of a given species which an area of land can support over the critical period of the year.

5. **COMPETITION** the general struggle for existence in which living organisms compete for a limited supply of the necessities of life.

6. **CONSUMER** an organism which obtains its energy from feeding upon plants or animals.

7. **ENVIRONMENTAL RESISTANCE** all the environmental factors which limit the population growth of a species.

8. **EXOTIC** any introduced non-native species in a community of plants and animals.

9. **FOOD WEB** the description of the flow of energy through the entire community of living things.

10. **HABITAT** the place where an organism lives.

11. **LIMITING FACTOR** any one of the environmental resistances which limit the population growth of a species.

12. **NICHE** the role or function that the organism plays in its habitat.

13. **OPEN SEASON** a period of time in which a certain species may be legally hunted.

14. **POPULATION** all the members of one species in a specific area or region.

15. **PREDATOR** an organism which preys upon other forms and eats them.

16. **PREY** an animal that is attacked and killed by another for food.

17. **RANGE** a region in which an organism lives and in which it can be expected to live.

18. **TERRITORY** the area surrounding an animal's home which he defends.

SECTION 2

1. **BALANCE** natural control of the growth of populations in nature by their interaction upon each other.

2. **BIOTIC COMMUNITY** definite and characteristic groups of plants and animals which include all the living members of a particular area.

3. **DECOMPOSER** chiefly the bacteria and fungi that break down the complex compounds of dead material, absorb some of the products, and release simple substances usable by producers.

4. **DISPERSAL** the current spread and distribution of a population in a given area.

5. **DIVERSITY** the extent of the varieties of living species.

6. **ECOSYSTEM** a segment of the environment in which living organisms and their nonliving habitat affect each other, or interact.

7. **ESTUARY** an area where tidal salt water mixes with the fresh water of a river or stream.

8. **FOOD CHAIN** the food relationships among plants and plant eaters and among animals and animal eaters.

9. **NATURALIST** a student or believer in the worth of nature, a student of the natural sciences.

10. **PRODUCER** plant life which can produce its own food by the process of photosynthesis.

11. **SANCTUARY** a management area, or refuge, where plant and animal species are protected.

GROUPS TO CONTACT AND SUPPORT

Protection of Wildlife

The Wildlife Society
Suite S-176
3900 Wisconsin Ave., N. W.
Washington, D. C. 20016

National Audubon Society
1130 Fifth Avenue
New York, N. Y. 10028
(American Committee for International Wildlife Protection, Inc.)

Ducks Unlimited
P. O. Box 66300
Chicago, Illinois 60666

The Humane Society of the United States
1604 K Street, N. W.
Washington, D. C. 20006

Defenders of Wildlife
2000 N Street, N. W.
Suite 201
Washington, D. C. 20036

Wildlife Management Institute
709 Wire Building
Washington, D. C.

Friends of Animals, Inc.
11 West 60th Street
New York, N. Y. 10023

World Wildlife Fund
Suite 728
910 Seventeenth St., N. W.
Washington, D. C. 20009

The Animal Protection Institute of America
P. O. Box 22505, Dept. FW-4
5894 South Land Park Drive
Sacramento, California 95822

Animal Welfare Institute
P. O. Box 3650
Washington, D. C. 20007

National Wildlife Federation
1412 Sixteenth St., N. W.
Washington, D. C. 20036

Preservation of Open Space

National Recreation & Park Association
1700 Pennsylvania Ave., N. W.
Washington, D. C. 20006

Open Space Institute
145 East 52nd Street
New York, New York 10022

The Nature Conservancy
1800 North Kent Street
Arlington, Virginia 22209

National Parks & Conservation Association
1701 Eighteenth Street, N. W.
Washington, D. C. 20009

The Wilderness Society
729 Fifteenth Street, N. W.
Washington, D. C. 20005

Keep America Beautiful, Inc.
99 Park Avenue
New York, N. Y. 10016

American Forest Institute
1835 K Street, N. W.
Washington, D. C. 20006

American Forestry Association
919 Seventeenth Street, N. W.
Washington, D. C. 20006

The Conservation Foundation
Information Division
U. S. Department of Agriculture
Washington, D. C. 20250

Resources for the Future, Inc.
1755 Massachusetts Avenue, N. W.
Washington, D. C. 20036

Soil Conservation Service
Information Division
U. S. Department of Agriculture
Washington, D. C. 20250

Soil Conservation Society of America
7515 N. W. Ankeny Road
Ankeny, Iowa 50021

SECTIONS OF THE UNIT	STUDENT RESOURCE BOOKLET	COMPONENTS TO COORDINATE WITH RESOURCE BOOKLET		
		Audio-Visual Materials	Ecomaster Activities	Extension Activities
Attitudes and Values	**Preface to the Unit** **Dead or Alive, A Story**	**Filmstrip 1** Why Wildlife? **Audio Cassette, Side A**	**Worksheet 1** Attitudes and Values Assessment (2 pages)	**Activity Card 1** Learning About Endangered Species
Finding Out by Looking Closely	**A Woodland Mystery** **Hints for Observing Birds** **Wildlife Detective Game: The Evidence**	**Wildlife Detective Game: The Culprit Cards**	**Worksheet 2** Observation Guide for Animal Study **Worksheet 3** Wildlife Detective Game: The Clues	**Activity Card 2** Counting the Animals In Soil Samples **Activity Card 3** How Do Insects Move and Navigate? **Activity Card 4** Observing the Behavior of People **Activity Card 5** More Uses for the Wildlife Detective Materials
Learning About Ecology	**A Year in the Life of a Twin Fawn** **Ecology: Principles and Problems** **The Tools of Wildlife Management**	**Overhead Transparencies** Habitat, Range, and Territory Biotic Community Producers, Consumers, and Decomposers Ecological Balance	**Worksheet 4** Where Do Pill Bugs and Sow Bugs Live? (2 pages) **Worksheet 5** Toothpick-Eating Animals	**Activity Card 6** Visiting a Hatchery **Activity Card 7** Doing Research on Exotic Species **Activity Card 8** Judging the Laws That Protect and Preserve
A Key Controversy: Land Use	**Facts on Land Use in the United States** **Development or Open Lands?**	**Filmstrip 2, Part A** Don't Fence Me In, A Story of Shrinking Spaces **Audio Cassette Side B**	**Worksheet 6** Land Development in Your Area	**Activity Card 9** Recreation Choices and Open Spaces **Activity Card 10** Preserving Open Space: Values and Opinions in Your Area
How You Can Help	**Helping a Threatened Population** **Suggested Strategies for Action** **Appendix of Information**	**Filmstrip 2, Part B** How You Can Help		